II. ENVIRONMENTAL SETTING

Landscape studies necessarily involve a wide range of studies treated in an interdisciplinary context. A landscape involves a range of interactions between human agents, biological organisms, and geological climatic contexts. The sum of these cognitive, biological, and physical interactions is living landscape evolution and its remnant or trace. Landscapes contain the residue of interactions left as soils, landforms, and archaeological sites. This chapter documents the physical and biological context of the site. The next chapter engages the cultural context. Pertinent general references to landscape studies are Crumley and Marquardt (1987), Gunn, Folan et al. (1995), Nassaney and Sassaman (1995), and Stine et al. (1997).

SITE SETTING

The project is located at the northeast city limit of Raleigh in northeastern Wake County, North Carolina, just south of the intersection of US Highway 401 and Mitchell Mill Road (SR 2224, Figure 2.1). Neuse Levee site (31WA1137) is located in a rapidly developing rural area. The overall project area is an approximately 30-m grid north-south, defined by the existing bridge on the north and the right-of-way boundary on the south. The grid east-west is approximately 20 m, defined by the occupied area of the levee, with the historic levee and Neuse River to the west and the backswamp to the east. A small, unnamed tributary of the Neuse River enters from the grid east just to the north of the existing bridge and 50 m north of the backhoe trench. It is now largely disrupted by US 401 construction, but could have been a contributing factor to the elevated character of the levee upon which the site resides. Also contributing to the site's geological character is its location in a sediment basin extending 1.2 km magnetic northwest and 1.0 km southeast from the site location. This basin appears on the 7.5 minute quadrangle as a flat floodplain between two bedrock constrictions in the Neuse River floodplain and between 170 and 180 feet AMSL (see Figure 2.1). Within the basin the river has meandered considerably, creating oxbows and levees.

PHYSIOGRAPHY

Wake County is located at the transition between the Piedmont and Coastal Plain physiographic provinces. Approximately 80 percent of Wake County is drained by the Neuse River. Although erosion has modified the original relief in many places, the terrain is predominantly gently rolling, with broad flat areas between stream drainages (Cawthorn 1970:113). Elevations in the county range from 49 m (160 feet) to 165 m (540 feet) AMSL, while the elevation in the project area is 53 m (174.9 feet) AMSL in the Neuse River channel at the low water level. Up a moderately steep bank in a two-stage levee, the elevation is 56.698 m (186.01 feet, Geologic Survey Station 1 at E100 N100) AMSL, with the site on the highest portion of the levee at 57.7 m (189.3 feet) AMSL.

The Inner Coastal Plain below the Fall Line is upslope from the Embayed section of the North Carolina coast, which includes the brackish transition zone between fresh and salt water (Fenneman 1938). In contrast with the less dissected section of the coast south of the Neuse River, the extensive estuaries of the Embayed section would have supported rich runs of anadromous fish. These differences in fish run density and river sedimentation processes continued up the Coastal Plain toward the Fall Line. The effects of the contrast can be seen in both historic and prehistoric population demographics. For example, both the coastal zone Algonkians and Inner Coastal Plain Tuscarora of the early historic period ended their southward distributions at the Neuse River (Phelps 1983).

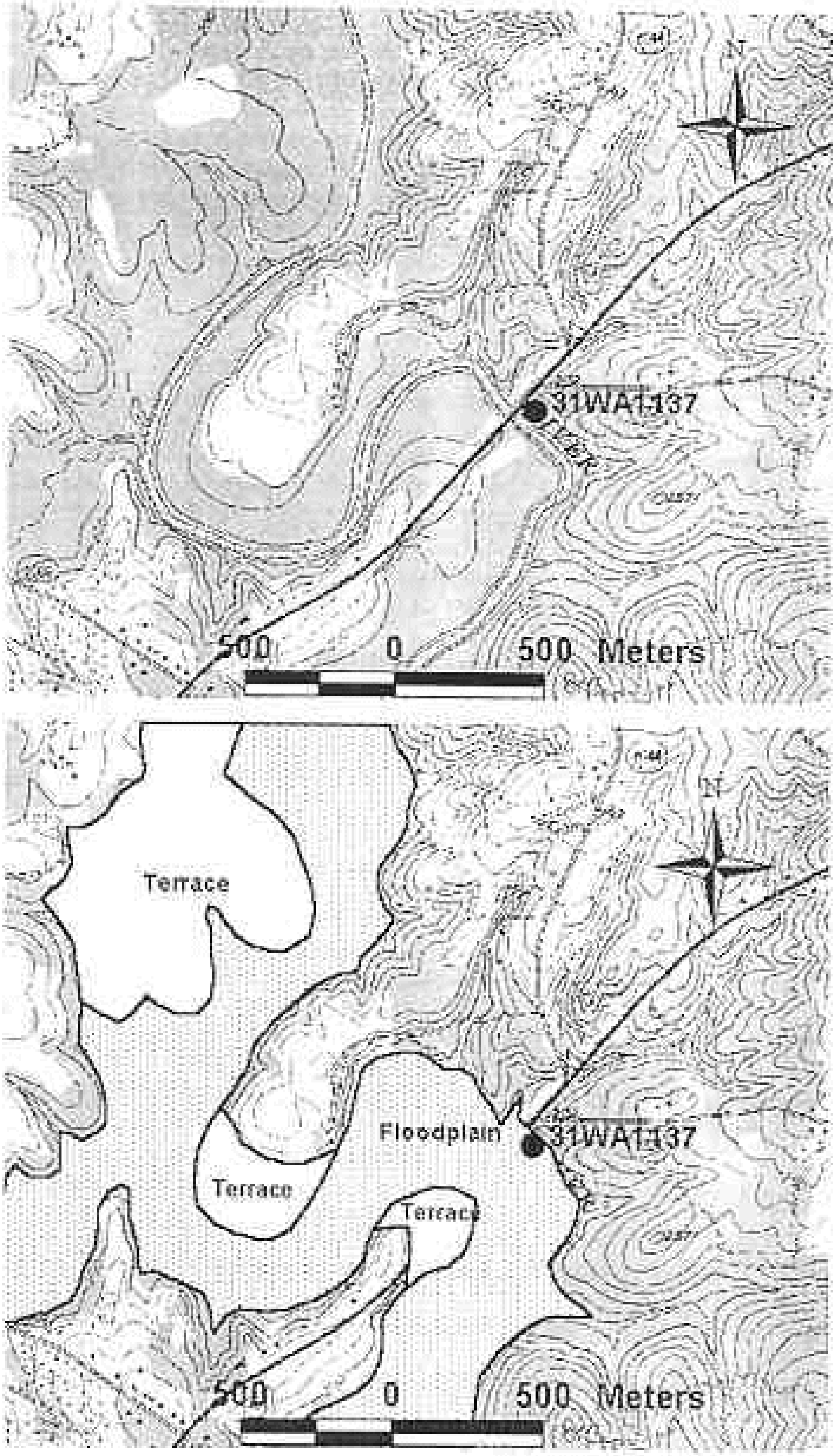

Figure 2.1. Topography and Geomorphology of the Project Area

GEOMORPHOLOGY (David S. Leigh, Ph.D.)

The Neuse Levee archeological site occurs on the cutbank side of a meander bend of the Neuse River near Raleigh, North Carolina, within an ancient natural levee (paleo-levee), which stands 3–4 m above the low water level and 0.5–1.0 m above the modern natural levee. Previous investigations (Glover 1993) identified a buried Archaic component (up to 1 m deep) associated with a curious assemblage of thin clay-iron bands (lamellae) within the paleo-levee deposits. This section describes the geomorphology, alluvial stratigraphy, pedology, and depositional history of the alluvial sediments at the site.

Methods

Field methods included a cross-sectional survey with a level to lay out the line of section of a backhoe trench perpendicular to the Neuse River. A 50-m-long backhoe trench was dug along the line of section. The trench was about 2 m deep and 1 m wide at the bottom with the top cut back 4 m to the east, for reasons of safety. The backhoe dug down to about 3.5 m (maximum digging depth) at intervals spaced about every 5 m in order to expose the deep stratigraphy and to search for dateable organic material. These deep pits were backfilled shortly after digging, for reasons of safety. The northwest, or grid north, side of the backhoe trench was cleaned with a shovel and trowel to expose the stratigraphy and soils for description and sampling. Additional subsurface sampling was done in several places with a 3-inch-diameter bucket auger, which was drilled down until refusal in alluvial gravels.

Soil profiles were described according to the terms of the USDA Soil Survey Manual (Soil Survey Division 1993) using moist Munsell colors and are given in Appendix 2. Soil and sediment samples are listed in Appendix 3. One set of soil/sediment samples (100–300 g) was collected from 20-x-20-cm blocks (samples 1–29), spaced 1–4 m apart, along horizontal transects within major stratigraphic units to characterize the physical and chemical properties of the stratigraphic units. Additional samples were collected from clay-iron bands and their adjacent soil matrix (samples 30–35). Another set of samples was collected from vertical profiles to characterize the variation of soil/sediment properties with depth (samples 36–65). An arbitrary 30-cm-thick sample interval was taken in vertical profiles, unless a horizon or stratum was less than 30 cm thick, which dictated the use of thinner sample intervals.

All soil/sediment samples were subjected to particle size analysis (weight percent of sand, silt, clay) by the hydrometer method as described by (Gee and Bauder 1986) using 50-g subsamples. An additional subset of samples was subjected to total inorganic chemical analysis by dissolution in a cocktail of hydrofluoric-nitric-perchloric acids and analysis by inductively coupled plasma spectrometry (ICP) by Chemex Labs, Incorporated. Total carbon and nitrogen analysis also accompanied the ICP chemical analysis, which was measured with a Leco® HNS analyzer. Three thin sections were prepared by National Petrographic, Incorporated, by impregnating the samples with epoxy resin and cutting and grinding in oil to produce a final 2-x-3-inch thin section (30 microns thick). Radiocarbon samples were analyzed by Beta Analytic, Incorporated.

Geomorphic and Landscape Setting

The site occurs along the outer part of a prominent meander bend near the northeastern edge of the Neuse River valley where it is crossed by US Highway 401 (see Figure 2.1). The river is dammed about 12.75 km upstream (river-kms) to make Falls Lake. The bankfull channel of the Neuse River is about 45 m wide and 3.5 m deep, with a gradient of about 0.001 near the site, and a gradient of about 0.0004 throughout the 24-km reach upstream and downstream from the site. Thus, the site appears to be along a slightly over-steepened segment of the river. The channel meanders through a valley that is about 0.5 km wide, including terrace remnants. The meander pattern is incised into the gneisses and schists of the lower Piedmont, and the valley is composed of Holocene and Pleistocene floodplain and terrace deposits.

The present channel bed consists of pea gravel, which typically ranges in size from 2 to 4 mm. The site occurs within sediments of a prehistoric natural levee (paleo-levee) of the Neuse River that is about 0.5 to 1.0 m higher than and 20 m northeast of the present natural levee (Figure 2.2). Historical sediment drapes most of the floodplain, where it is up to 4 m thick, but is only about 10 to 20 cm thick on the paleo-levee (see Figure 2.1).

Alluvial Stratigraphy

Results indicate the presence of five alluvial stratigraphic units at the site (Figure 2.2), which are characterized in the profile descriptions (Appendix 2) and are summarized here. Radiocarbon dates that relate to the alluvial stratigraphy are presented in Table 2.1.

Table 2.1. Radiocarbon Dates Relevant to the Alluvial Stratigraphy at Neuse Levee.

Lab Number	Material Dated	^{14}C years B.P. ± 1 Standard Deviation (^{13}C normalized)	Calendar Age
Beta-118366	Uncarbonized Wood in Unit 4 @ 400 cm Depth	170 ± 50	A.D. 1780 ± 50
Beta-118367	Uncarbonized Wood in Unit 3 @ 450 cm Depth	1960 ± 50	10 B.C. ± 50
Beta-118287	Charcoal Flecks in Bt Horizon of Unit 1 @ 170 cm Depth	7270 ± 60	5320 B.C. ± 60
Beta-118288	Hickory Nut in Unit 1 @ 550 cm Depth	10,160 ± 80	8210 B.C. ± 80

Units 1 and 2 comprise a prehistoric natural levee, which contains sediments ranging in age from about 10,000 to 250 yr B.P. Unit 2 drapes unit 1 and contains most of the artifacts at the site. Unit 3 is late prehistoric slackwater floodplain sediment that ranges from about 2000 to 250 yr B.P. Unit 4 is historical alluvium that forms the present natural levee along the Neuse River, and unit 5 is historical gravel on the bed and bars of the Neuse River. Figures 2.3–2.9 provide comparisons between the sediment textures of each unit. Note that each of the stratigraphic units exhibits a general distance-decay pattern in terms of textural fining, with percent sand and the sand/silt ratio decreasing with distance from the levee crest, whereas the percent silt and clay increases. Such a pattern is typical of natural levee sediments.

It is significant to note that the gravel at the base of units 1–4 is more than 1 m below the unit 5 gravel in the modern stream bed (see Figure 2.2), indicating that the present stream bed has aggraded. Engineering boring logs (Law Engineering and Environmental Services 1996) indicate that the basal gravel in units 1–4 is about 0.7–0.8 m thick and that it overlies weathered bedrock.

Unit 1

Unit 1 is the oldest stratigraphic unit at the site and consists of basal alluvial gravel that is conformably overlain by overbank sediments. These sediments consist of sandy loam and loam textures and are massive, pedogenically altered, and exhibit no primary sedimentary structures. The lower half of the overbank deposits are gleyed with unoxidized gray colors (5Y hues) that grade upward into mottled gray and yellowish brown colors (2.5Y hues). The upper half of unit 1 exhibits a well-oxidized weathering profile, which includes a yellowish brown (10YR hues) Bt horizon (Appendix 2), and indicates a hiatus (or at least a reduction) in sedimentation that allowed weathering and soil formation. The upper surface of unit 1 is irregular and exhibits slight depressions (see Figure 2.2) that may have resulted from shallow erosional scour immediately prior to deposition of unit 2.

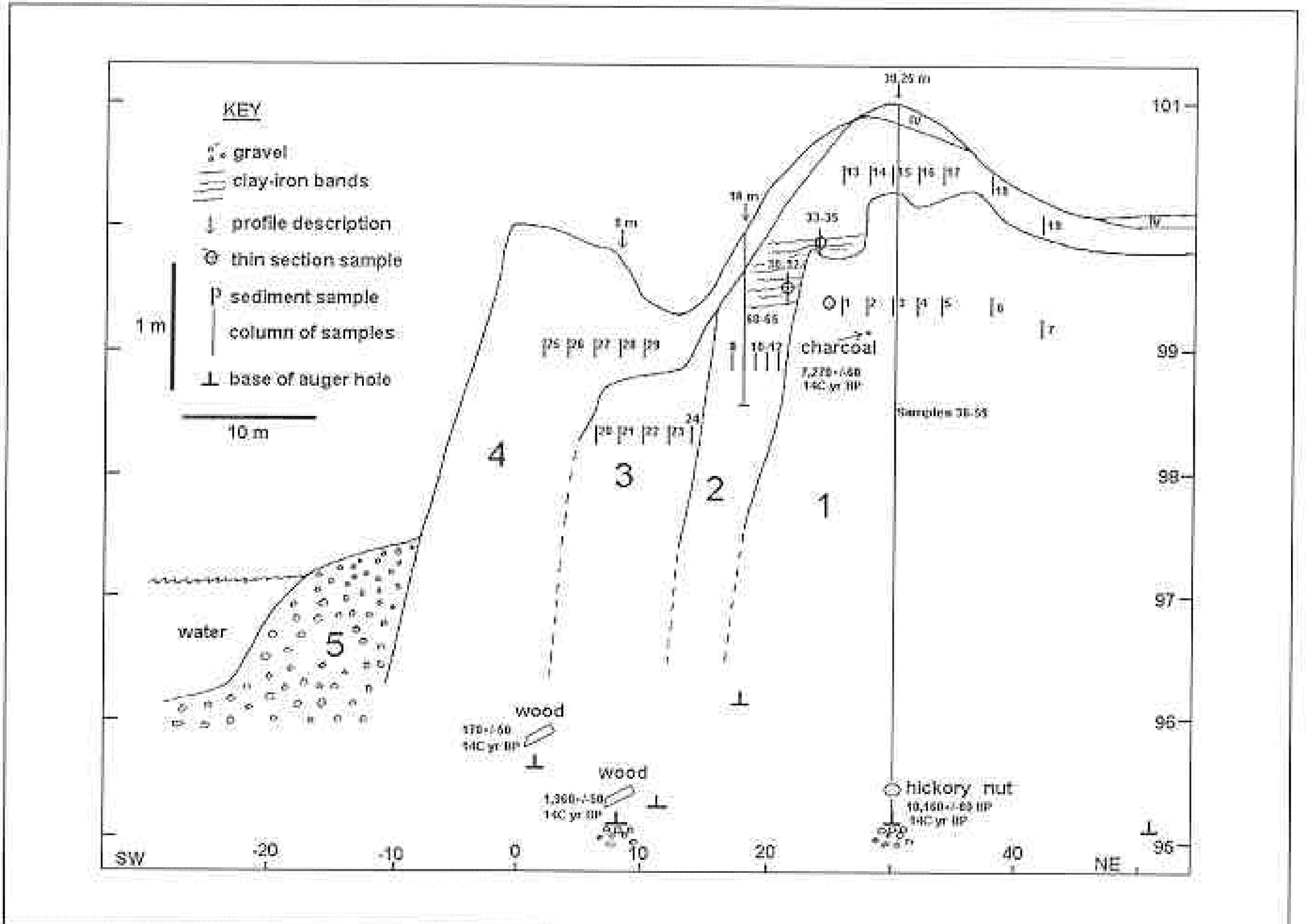

Figure 2.2. Stratigraphic Cross-Section of the Floodplain at 31WA1137. The scale is in meters, which do not correspond to the site datum. The section is perpendicular to the Neuse River channel.

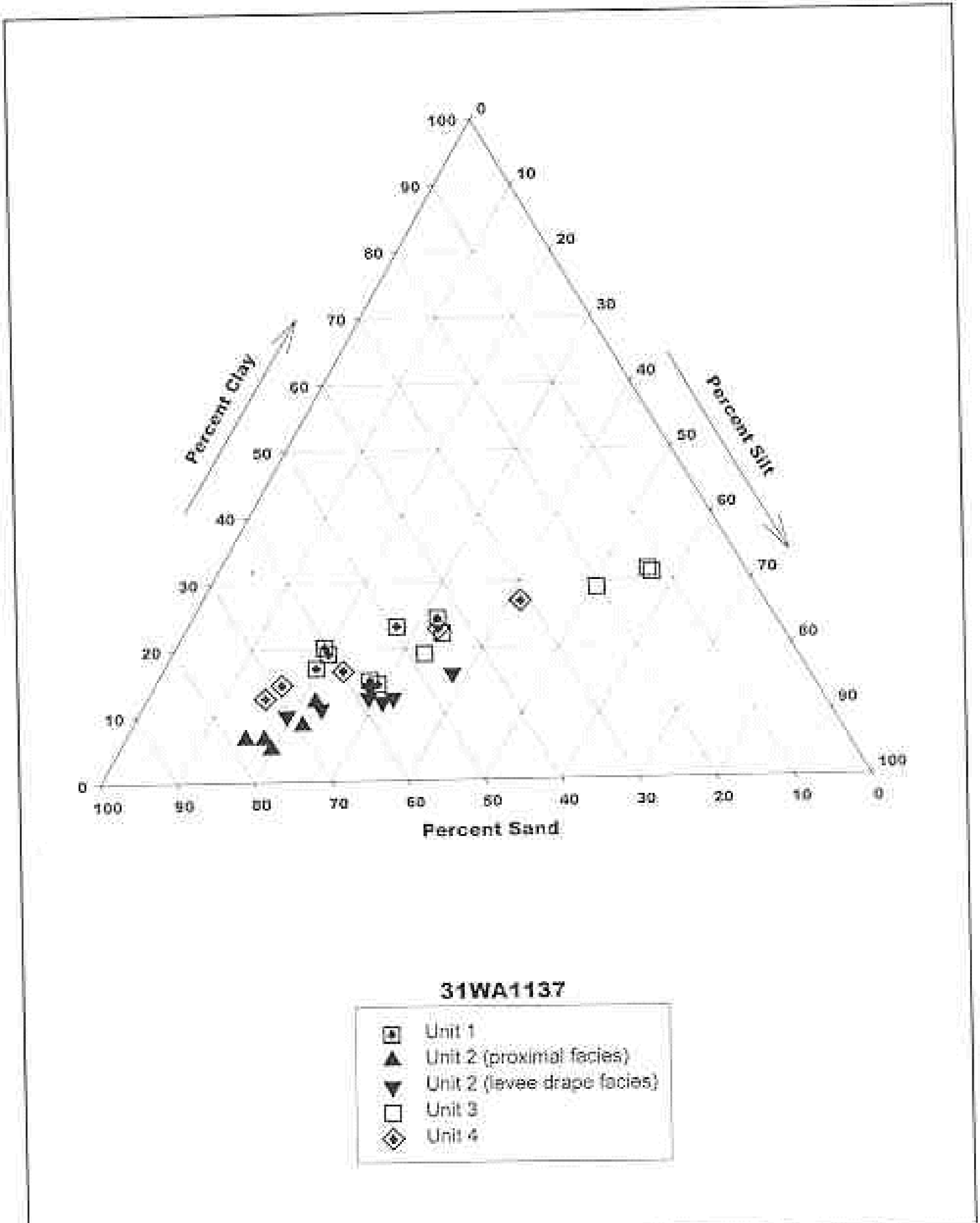

Figure 2.3. Ternary Plot of Sand, Silt, and Clay Percentages of Samples 1–29 that are Representative Grab Samples from Each of the Stratigraphic Units at 31WA1137. Note that unit 2 typically contains more silt and less clay than the other stratigraphic units.

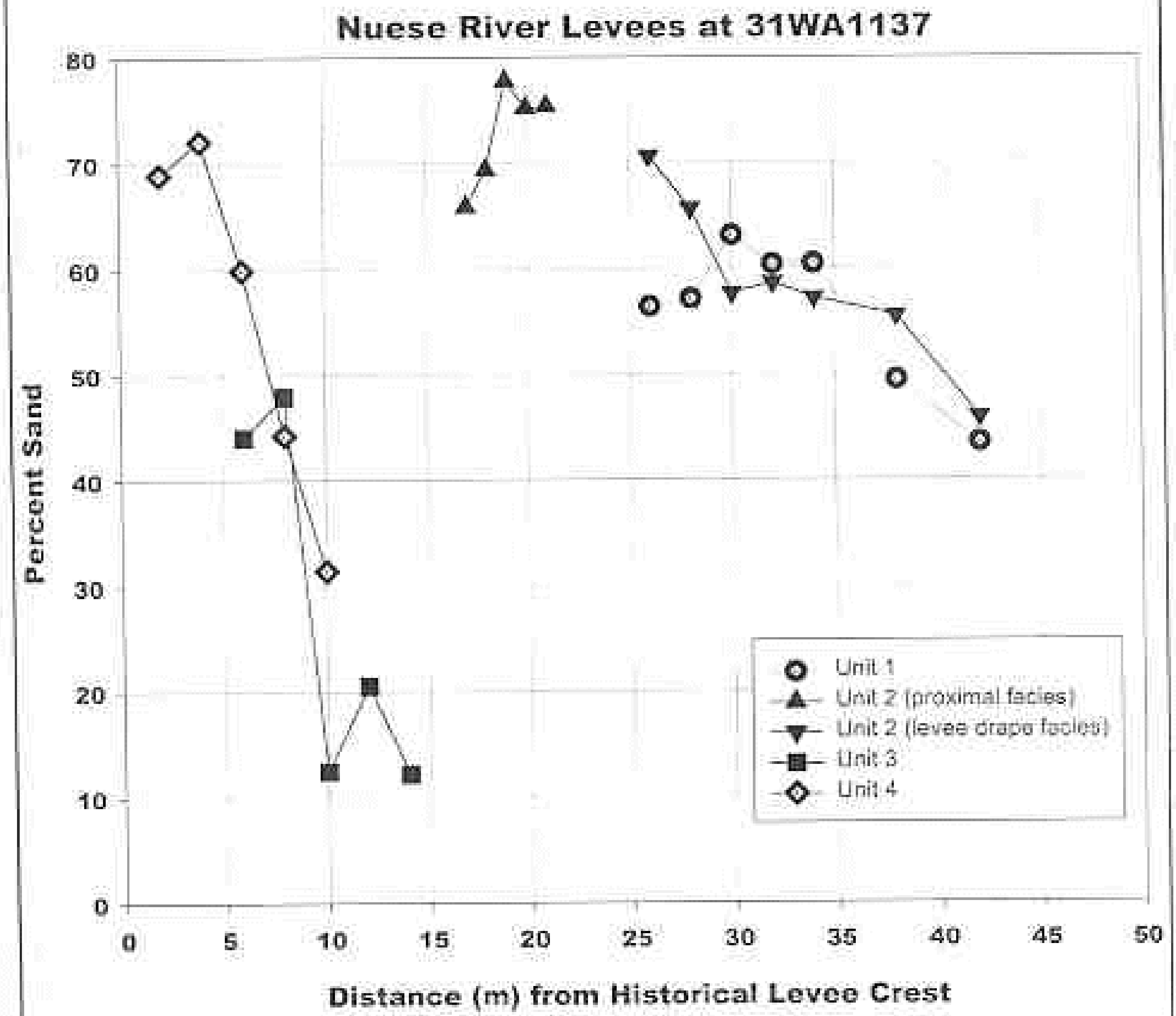

Figure 2.4. Plot of Percent Sand as a Function of Distance from the Modern Levee Crest, Illustrating the General Distance-Decay Functions of Particle Size away from the River Channel Position. The paleo-levee crest for units 1 and 2 would have been at about 30 m distance.

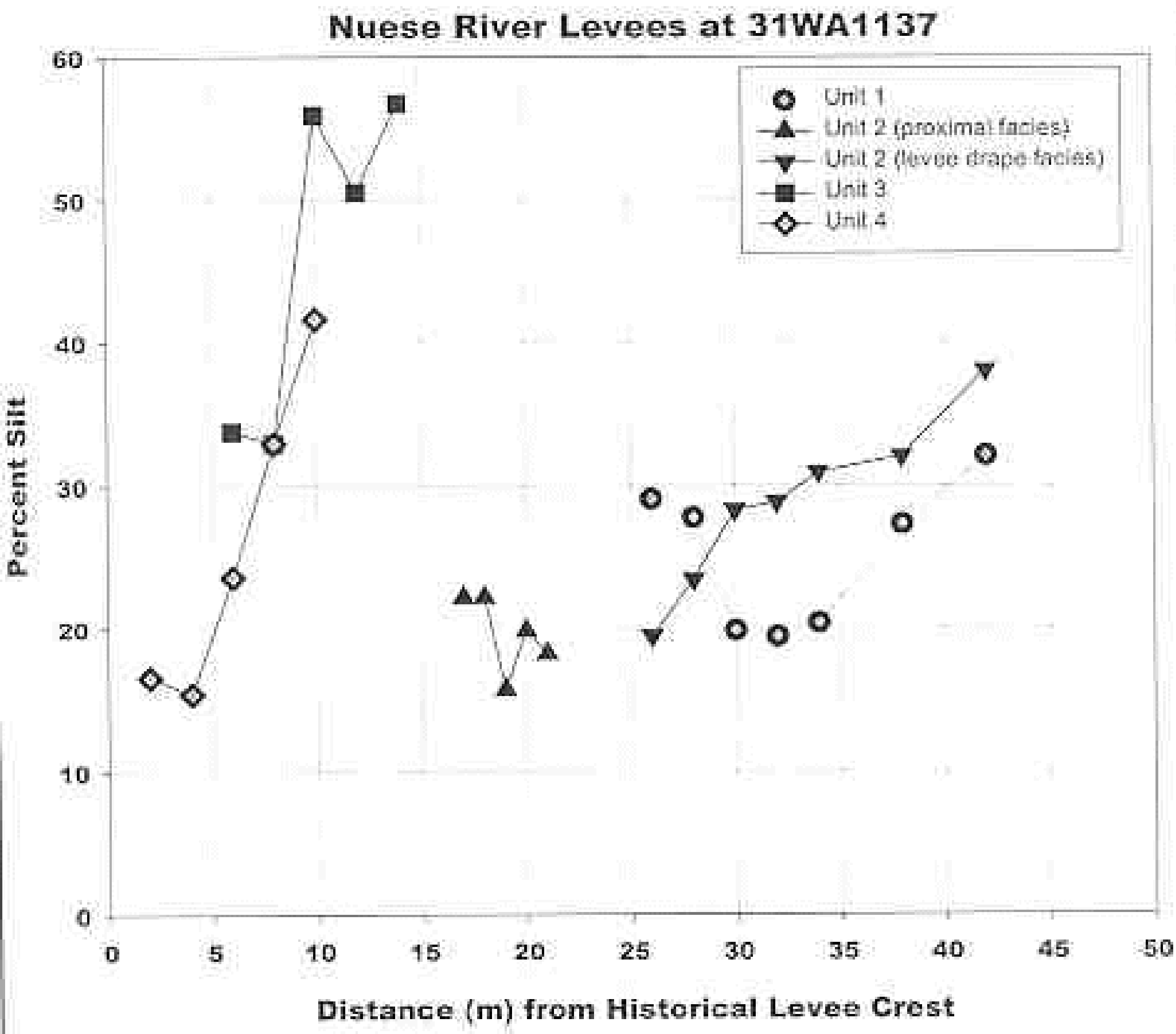

Figure 2.5. Plot of Percent Silt as a Function of Distance from the Modern Levee Crest, Illustrating the General Distance-Decay Functions of Particle Size away from the River Channel Position. The paleo-levee crest for units 1 and 2 would have been at about 30 m distance.

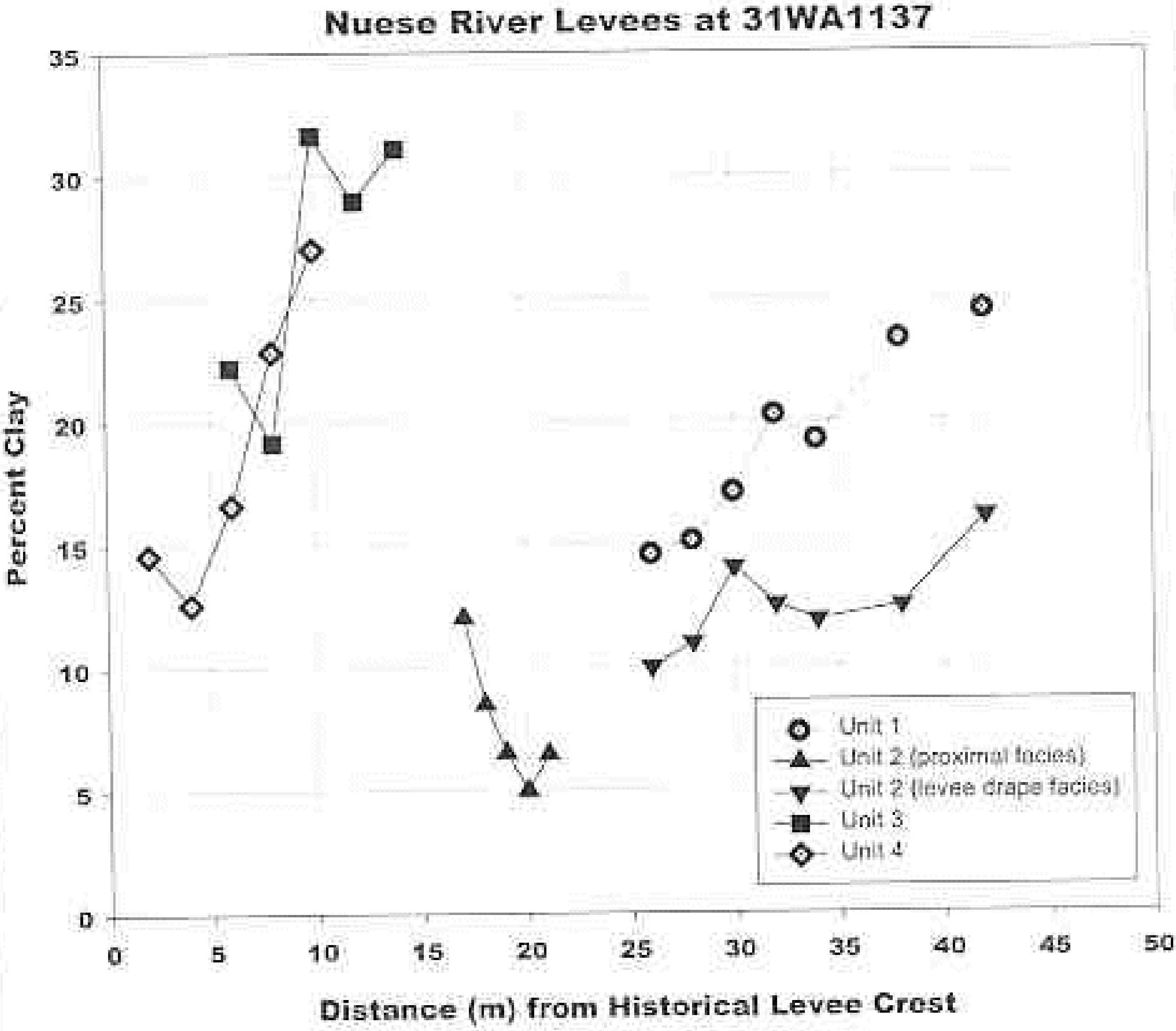

Figure 2.6. Plot of Percent Clay as a Function of Distance from the Modern Levee Crest, Illustrating the General Distance-Decay Functions of Particle Size Away from the River Channel Position. The paleo-levee crest for units 1 and 2 would have been at about 30 m distance.

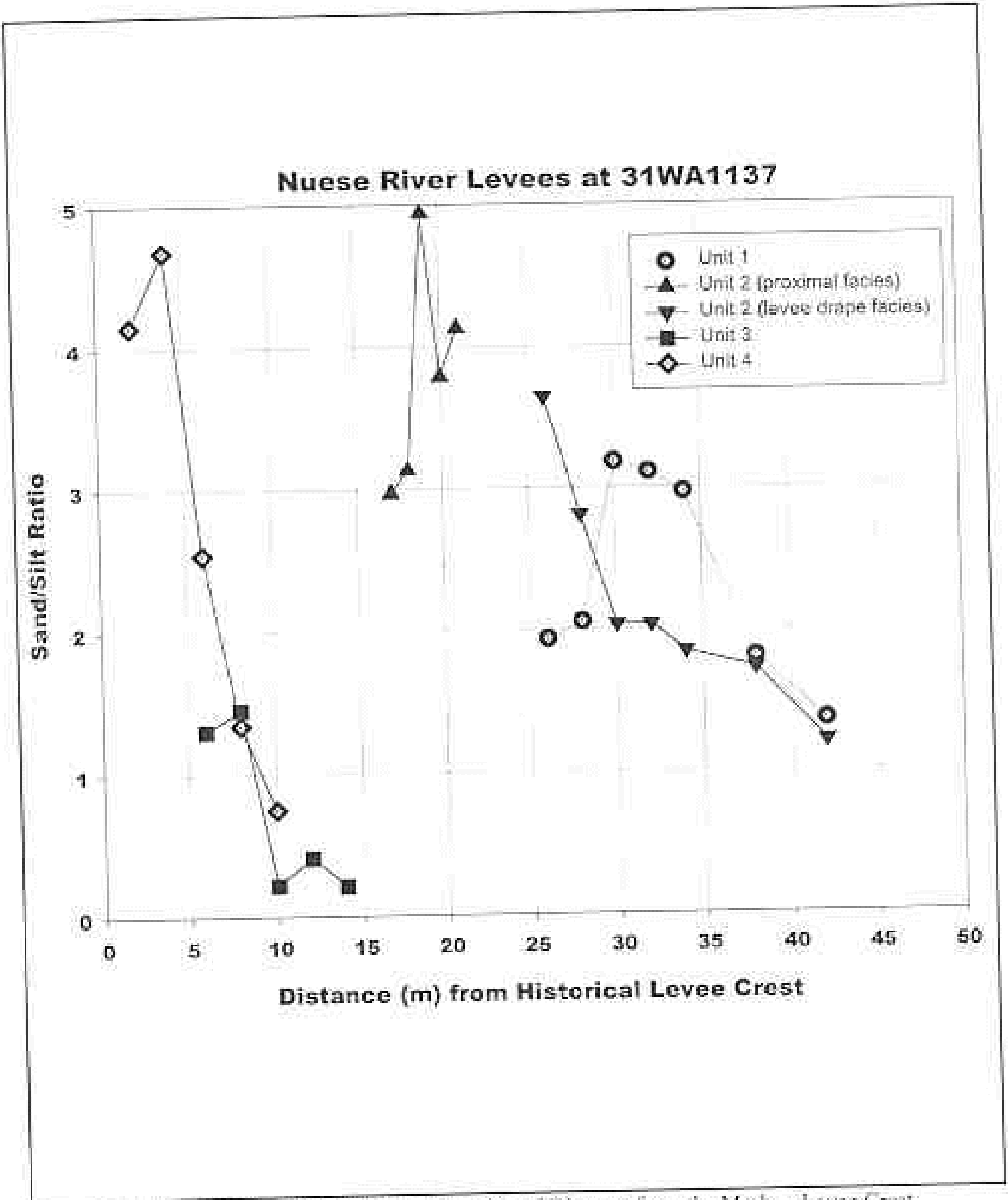

Figure 2.7. Plot of the Sand/Silt Ratio as a Function of Distance from the Modern Levee Crest, Illustrating the General Distance-Decay Functions of Particle Size Away from The River Channel Position. The paleo-levee crest for units 1 and 2 would have been at about 30 m distance. The sand/silt ratio removes the influence of pedogenic clay on the particle size distribution, and thus it is useful in resolving the sedimentology.

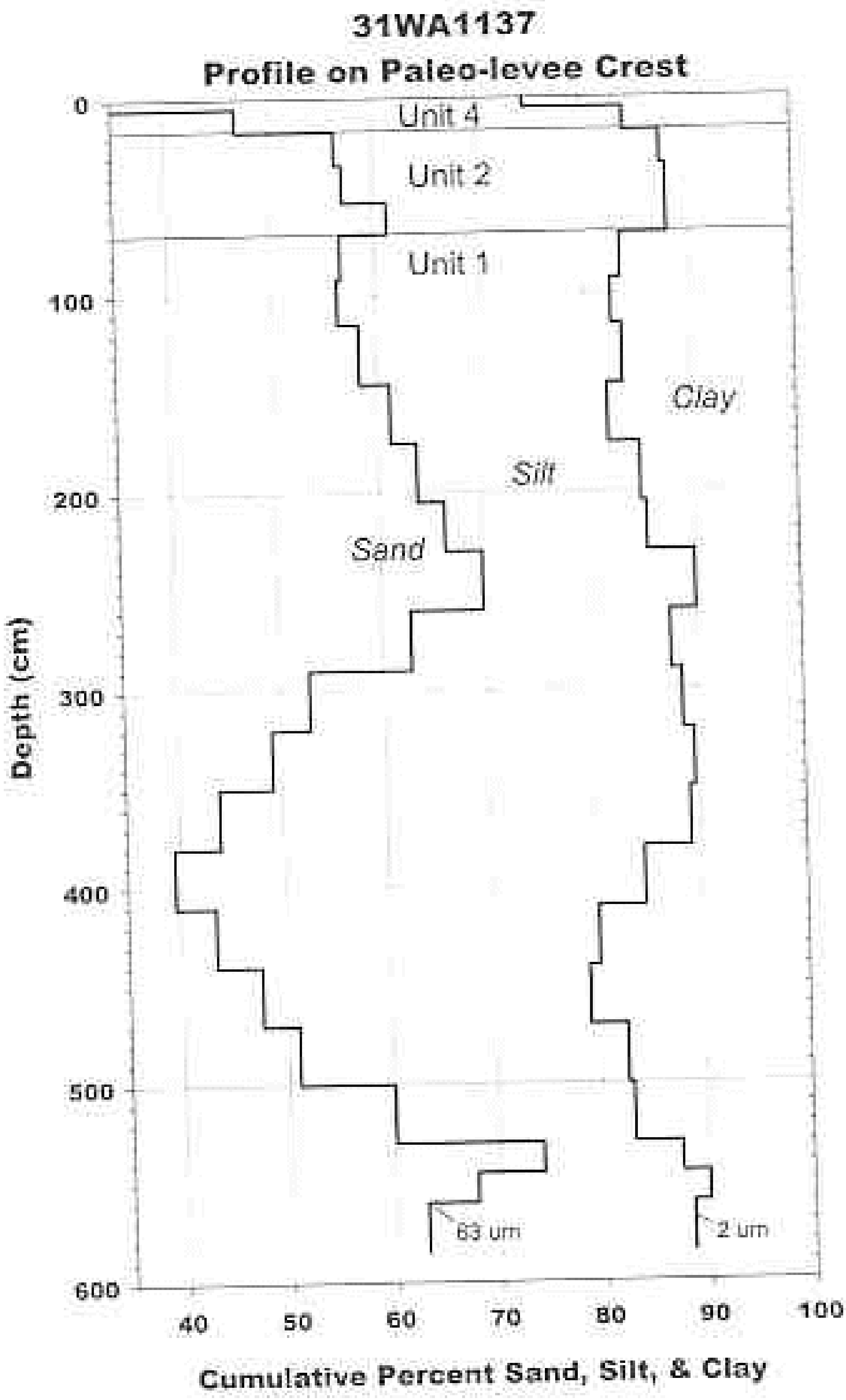

Figure 2.8. Particle Size Distribution of the Vertical Column of Samples Extending Down from the Crest of the Paleo-Levee at Site 31WA1137, Consisting of Samples 36–59 At 30.25 m Northeast of the Modern Levee Crest.

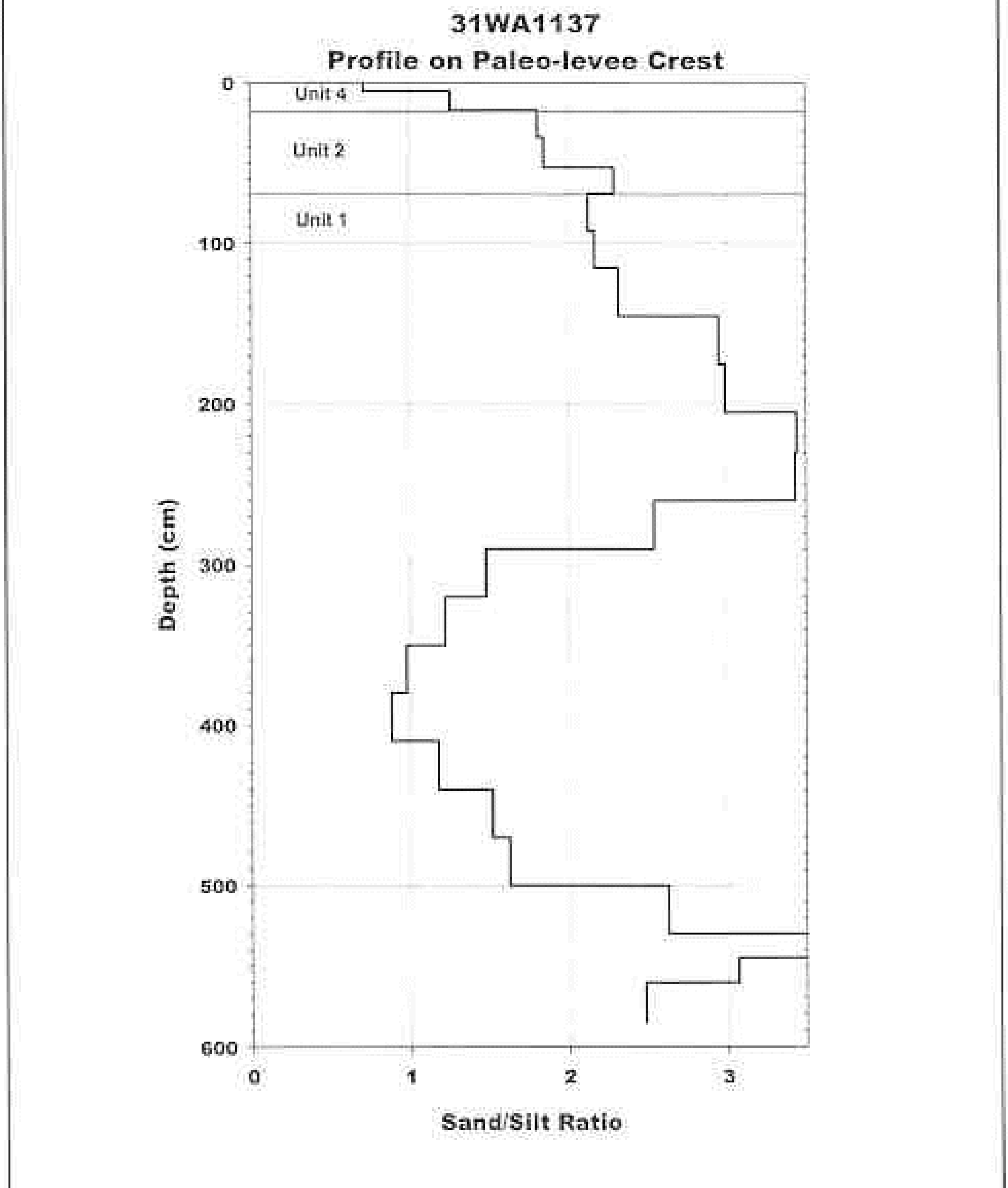

Figure 2.9. Plot of the Sand/Silt Ratio Values of the Vertical Column of Samples Extending Down from the Crest of the Paleo-Levee at Site 31WA1137, Consisting of Samples 36-59 at 30.25 m Northeast of the Modern Levee Crest.

Figures 2.3–2.7). Deep test excavations down into unit 1 indicate that it is culturally sterile. A basal AMS radiocarbon date from a hickory nut (*Carya aquatica*) in unit 1 at 550 cm depth (just above gravel) is 10,160±80 ^{14}C yr B.P., and another AMS radiocarbon date from unit 1 on charcoal flecks at 170 cm depth is 7,270±60 ^{14}C yr B.P. The 7,270±60 ^{14}C yr B.P. date is viewed as a minimum age because the charcoal may be intrusive or from a burned root, and because the presence of the buried Bt horizon at the top of unit 1 indicates a hiatus in sedimentation prior to 6,250 yr B.P. (or the time of Savannah River culture) that was arguably longer than 1,000 years, based on the level of Bt horizon development.

Particle size analysis of the sample column that extends down from the crest of the paleo-levee (samples 36–59, see Figure 2.2) indicates that unit 1 has three distinct graded sequences of overbank sedimentation (see Figures 2.8–2.9), including: (1) a fining-upward trend from the basal gravel at 585 cm up to about 380 cm depth; (2) a coarsening-upward (reverse graded) sequence from 380 to 230 cm depth; and (3) a fining-upward trend from 230 to 69 cm depth. These graded sequences probably resulted from the movement of the riverbank relative to the position of the sample site through time. That is, fining-upward sequences occurred when the river moved away or stayed in about the same place (a "normal" graded sequence), and coarsening-upward sequences occurred when the riverbank was cutting toward the site and the loci of high-energy sedimentation was getting progressively closer to the site through time (levee progradation or "reverse" graded sequence).

Unit 2

Unit 2 contains the prehistoric artifacts at the site. It juxtaposes and drapes unit 1, and is generally distinguished from unit 1 by having more silt and less clay (see Figures 2.3, 2.5, and 2.6). It typically consists of massive yellowish brown to light yellowish brown (10YR 5/4 to 6/4) fine sandy loam that grades downward into gleyed sediments. The boundary between unit 1 and unit 2 is conformable and is somewhat obscured by incipient Bt horizon formation (clay-iron lamellae). However, an irregular and possibly scoured surface at the top of unit 1 suggests that a brief period of erosion may have preceded the deposition of unit 2. Chemical data suggest that unit 2 indeed represents renewed sedimentation upon unit 1 (following a brief period of weathering in unit 1), because unit 2 has higher Ca/Ti, K/Ti, and Na/Ti ratios than unit 1 (Appendix 3), which are indicative of less weathered sediment. In addition, the general fining-upward trend in unit 1 from 230 cm toward the surface is interrupted by a pulse of sandy sediment that marks the base of unit 2 (see Figures 2.8 and 2.9 @ 53–69 cm depth, sample #40), and a different style of sedimentation on top of unit 1. A radiocarbon date of 1,960±50 ^{14}C yr B.P. from wood at the base of unit 3, and Woodland artifacts recovered near the top of unit 2, indicate a terminal age of about 2000 yr B.P. for unit 2, and Savannah River artifacts at the base of unit 2 indicate a basal age of c.4000 yr B.P., which is supported by the subjacent 7,270±60 ^{14}C yr B.P. date at about 1 m below the base of unit 2.

Unit 2 is subdivided into two subunits, including: (1) proximal facies and (2) levee drape facies. The proximal facies exist on the river channel side of the levee and descend down the proximal side of the levee to basal gravel, whereas the levee drape facies simply cap unit 1 along the top of the paleo-levee (see Figure 2.1). Figures 2.3–2.7 reveal that the proximal facies are of significantly coarser texture than the levee drape facies.

Clay-Iron Bands in Unit 2

An interesting attribute of unit 2 is the abundance of thin (1–3 cm thick) clay-iron bands (lamellae or beta-B bands) that occur within the proximal facies of unit 2 and on the river side of the levee crest in unit 2 (Figure 2.10; see Figure 2.2). Particle size analysis indicates that these clay-iron bands contain 14–15% clay and 2.0–2.1% iron, whereas their surrounding matrix contains 8% clay and 1.5–1.8% iron (samples 30–35, Appendix 2). Thin sections of these clay-iron bands reveal that there is no sedimentary difference between the matrix and clay-iron bands in the coarse fraction (Figure 2.11), and that the clay

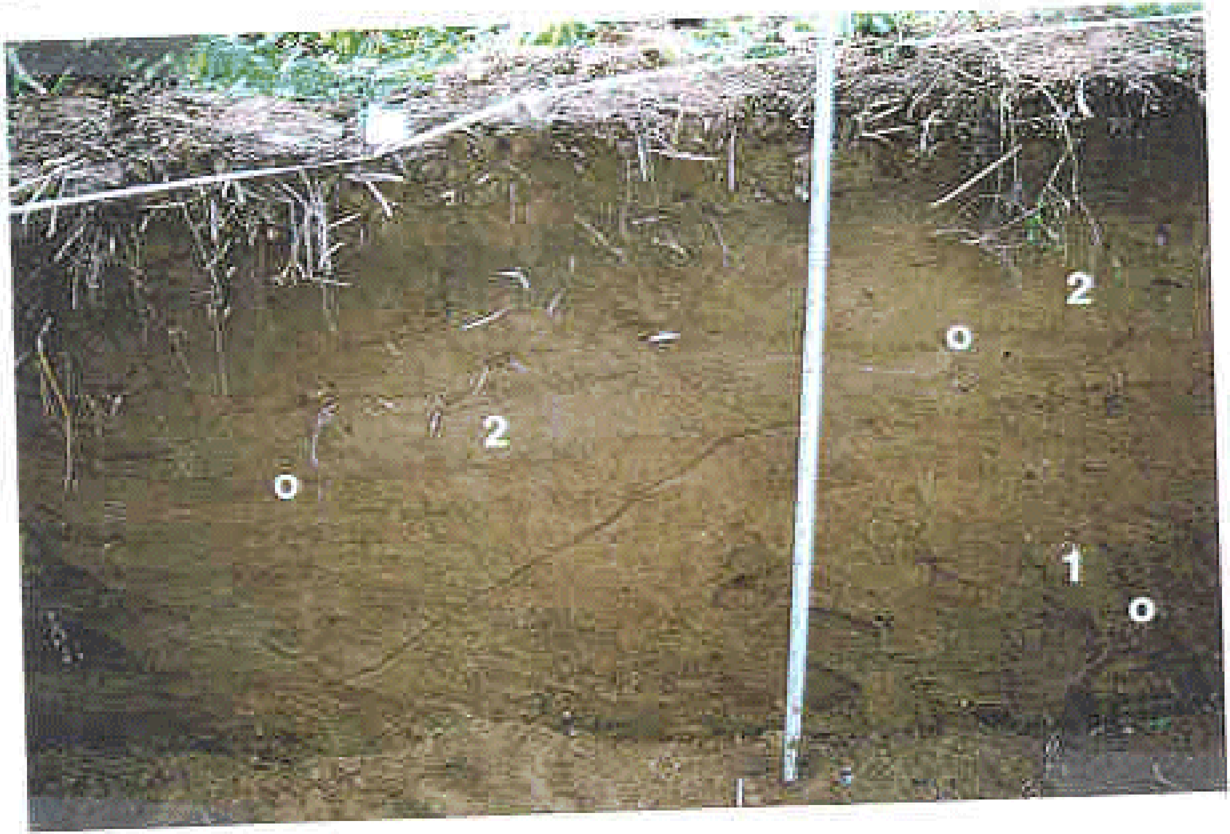

Figure 2.10. Photograph Illustrating the Clay-Iron Bands in Unit 2 on the Proximal Side of the Paleo-Levee Crest. The line etched into the profile marks the approximate boundary between units 1 (marked "1") and 2 (marked "2"). The clay-iron bands merge with the Bt horizon in unit 1 and obscure the lithic boundary between units 1 and 2. Thin sections (see Figures 2.11 and 2.12) of the clay-iron bands indicate that they are of pedogenic origin, resulting from illuvial clay translocated down the soil profile. The location of the thin section studied are indicated by white o's. The thin section shown in Figures 2.11 and 2.12 is the one immediately to the upper right of the stadia rod. One of the thin sections was from the Bt horizon in unit 1, which confirmed presence of illuvial clay in that horizon. The trench height on the stadia rod is 2.20 m for scale.

Figure 2.11: Thin Section Photomicrograph of the Upper Boundary of a Clay-Iron Band under Plane Polarized Light at 20X Magnification. The frame width is approximately 60 mm. The dark matrix in the lower half is the clay-iron band, and the light matrix in the upper half is clean sand. Note that there is no apparent sedimentological difference between the sands in the clay-iron band and the sand above it.

enrichment is entirely of pedogenic origin. The pedogenic origin is indicated by the presence of microlaminated clay that fills pores and channels (Figure 2.12), which is diagnostic of pedogenic illuvial clay enrichment (Brewer 1976; Fitzpatrick 1984). Recent studies at other sites on natural levees in the Southeast also concluded a pedogenic origin (illuviation) for clay-iron bands (Larson and Schuldenrein 1990; Leigh 1998), which contradicts an earlier paper by Robinson and Rich (1960) concerning clay-iron bands in soils of the Southeast. In other parts of the United States, clay-iron bands typically have been explained by the process of clay illuviation (Berg 1984; Folks and Riecken 1956; Gile 1979; Wurman et al. 1959).

Unit 3

Unit 3 is a late Holocene slackwater deposit that ranges from about 2000 to 250 yr B.P. It consists of brown (7.5YR 4/4) to light olive brown (2.5Y 5/4) silty clay loam to loam with many light gray (2.5Y 7/2) mottles near its top, becoming coarser textured and unoxidized (5Y hues) with depth. Slight B horizon development is apparent in the upper part of unit 3, which is unconformably overlain by unit 4. A radiocarbon date of 1,960±50 ^{14}C yr B.P. near the base of unit 3 indicates a basal age of circa 2000 yr B.P. A radiocarbon date of 170±50 ^{14}C yr B.P. near the base of the overlying unit 4 indicates an upper age limit of circa 200–250 yr B.P. Unit 3 is characteristic of back-levee and backswamp sedimentation, and thus lacks much potential for containing in-situ Woodland artifacts.

Unit 4

Unit 4 is historical alluvium that makes the present natural levee along the Neuse River. It is characterized by thinly stratified and laminated sandy loam that is predominantly dark yellowish brown (10YR 4/4) in color, but includes numerous layers of lighter (2.5Y 7/2) and darker (10YR 3/2) strata. Unit 4 unconformably overlies unit 3 and makes the modern natural levee of the Neuse River. Three trees, dated by dendrochronology in the 70–90-year age range, were cored to estimate sedimentation rates during the time of tree growth based on the depth of their buried root crowns. This is a technique known as dendrogeomorphology (Hupp and Bazemore 1993). These trees indicated a sedimentation rate of 1–2 cm per year for the upper part of unit 4. A radiocarbon date of 170±50 ^{14}C yr B.P. at 400 cm depth in unit 4 indicates a long-term sedimentation rate of 1.8 to 3.3 cm per year. These sedimentation rates are about one order of magnitude higher than the fastest prehistoric rates and are consistent with the idea of rapid historical sedimentation resulting from agricultural and urban transformations of the Piedmont landscape (Trimble 1974).

Unit 5

Unit 5 is historical gravel on the bed and bars of the Neuse River. The most significant aspect of this gravel is that its surface is more than 1 m above the level of gravel in units 1–4. This indicates that the Neuse River bed has experienced significant aggradation during late historic time, perhaps within the last 100 years. It is possible that the channel bed aggradation is related to frequent releases of water from the dam upstream, which has scoured gravel immediately downstream of the dam and redeposited some of that gravel in the river reach near 31WA1137.

Geochemical Trends

Total chemical analysis was performed on all of the samples in the column extending down from the crest of the levee (samples 36–59), as well as on many other samples (Appendix 3). These data primarily were used to discern obvious differences between the stratigraphic units and to explore phosphorus concentrations for any anomalies in the vertical column that may have resulted from cultural activity. The results indicate a clear difference between units 1 and 2, based on the Ca/Ti, K/Ti, and Na/Ti ratios, as indicated earlier. Such a difference results from the relatively fresh and unweathered mineralogy of unit 2 compared to unit 1, which suggests that unit 1 had experienced some weathering

Figure 2.12. Close up (200X) Photomicrograph of the Microlaminated Illuvial Clay (Orange Pods with Black Bands Noted with an "i" on the Photo) In a Clay-Iron Sand Under Polarized Light. Frame width is approximately 0.60 mm. The black bands that extend vertically through the orange clay pods are optical extinction bands, which indicate that the clay in the pod is preferentially oriented perpendicular to the extinction band, which indicates that it is microlaminated (or illuvial) clay. Note that the micro-laminated clay fills pores and voids between sand grains, which is also indicative of pedogenic illuvial clay.

prior to the deposition of unit 2, or that units 1 and 2 have a different provenance, or both. Although unit 2 contains the E horizon of the soil profile on the paleo-levee crest, the relatively fresh chemical signature of unit 2 (e.g., higher Ca/Ti, K/Ti, Na/Ti ratios) suggests that it is not as weathered as unit 1.

The possibility of finding phosphorus trends indicative of cultural activity was explored for the vertical columns of samples 36–59 and samples 60–65, based on the premise that cultural activity tends to elevate phosphorus concentrations in soil (Goffer 1980; Walker 1992). In both columns there is a progressive decrease in the phosphorus concentration and in the residual phosphorus values (Appendix 3, P and Res. P) with depths below the prehistoric buried A horizon at the top of unit 2. The residual analysis, which normalizes phosphorus concentrations with respect to percent carbon and percent clay, indicates that the Woodland occupation in the buried A horizon atop unit 2 is the only zone that registers cultural additions of phosphorus to the soil, with a residual value of 49 ppm (parts per million) (Appendix 3). Such additions may include bones or oil from fish processing, ash from fires, dung, and other residues. Curiously, the zone of Savannah River cultural materials beneath the levee crest does not register a phosphorus peak, which may suggest few activities by the Savannah River people that generated phosphorus residue. Perhaps the Savannah River people were only using the site for cobble reduction of lithic material obtained from the river channel.

Beneath the known cultural horizons, at a depth of 350–380 cm there appears to be a peak in phosphorus, represented by sample #51 with a residual phosphorus value of 60.7 ppm (Appendix 3). This may suggest cultural activity at greater depth or some other sort of phosphorus anomaly.

Depositional History

Lateral Migration of the Neuse River

At some time prior to 10,000 yr B.P. the Neuse River channel incised down to the minimum elevation represented in the cross-section (see Figure 2.2), as indicated by the 10,160±80 ^{14}C yr B.P. date. At 10,000–11,000 yr B.P. the channel was probably situated on the northeastern margin of the valley and deposited the gravel beneath that radiocarbon date. After 10,000 yr B.P. the channel migrated back to the southwest and stayed southwest of the paleo-levee crest while it migrated back and forth a number of times. A hypothetical sequence of channel migration, inferred from the graded sedimentary sequences in unit 1 and cut-and-fill stratigraphic sequences, is illustrated in Figure 2.13 and discussed below.

At times between 10,000 and 7000 yr B.P. the river channel progressively migrated (relative to the 30-m mark on the paleo-levee crest in Figure 2.2) away from the site to the southwest, back toward the site to the northeast, and finally away from the site to the southwest, producing the normal-reverse-normal graded sequence apparent in the overbank deposits of unit 1. Unfortunately, it is impossible to tell how far the channel migrated without radiocarbon dates from alluvium on the other side of the valley. Between 10,000 and 7000 yr B.P., the sediments beneath the paleo-levee were gradually aggrading at a rate of about 0.20–0.10 cm/year to form unit 1. At some time c.7,000–6,000 B.P., shortly prior to the Savannah River occupation, the channel migrated back toward the crest of the paleo-levee and eroded the upper part of unit 1 that is juxtaposed and covered by unit 2. The irregular surface noted atop unit 1 was scoured at this time. In addition, the first layers of unit 2, containing the Savannah River component, were deposited immediately following this episode of scouring. The people who created the Savannah River artifact scatter were probably living immediately adjacent to the river bank. In the time following the Savannah River occupation (c.6000–2000 yr B.P.), the channel gradually migrated away from the crest of the paleo-levee, depositing unit 2. At some time c.2000 yr B.P. the channel probably reversed its direction and cut back into unit 2, then reversed its migration back to the southwest, depositing unit 3. At some time c.250 yr B.P. the channel reversed direction again and cut into unit 3. This migration was followed by a reversal back to the southwest and the emplacement of the modern natural levee and the sediments of units 4 and 5. In recent decades the channel bed has aggraded, perhaps in response to dam releases, resulting in the relatively high elevation of the channel bed gravel in unit 5.

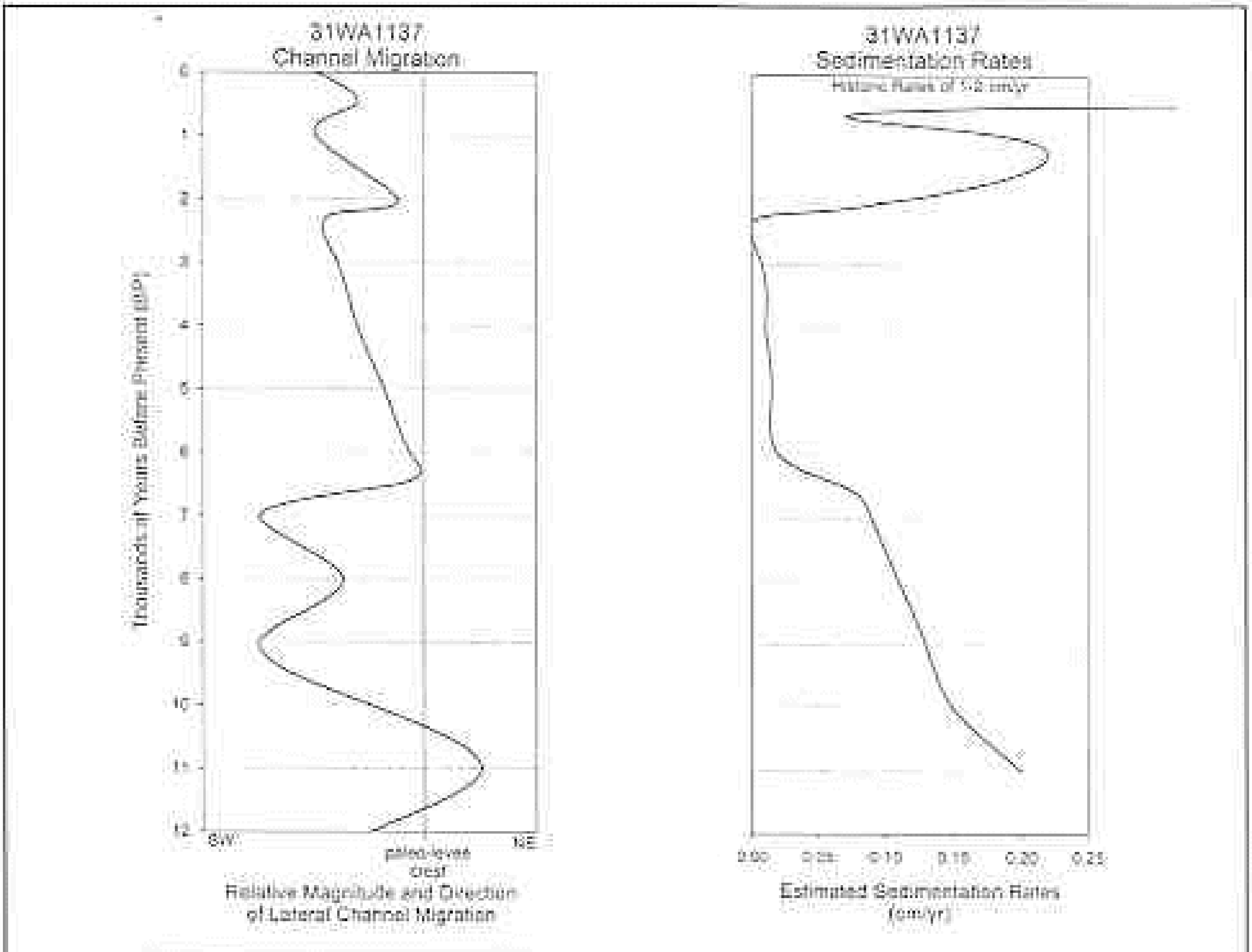

Figure 2.13. Hypothetical Variation in the Direction of Lateral Channel Migration and Sedimentation Rates at Site 31WA1137.

Sedimentation Rates

Long-term average sedimentation rates for the overbank sediments can be inferred from the available radiocarbon dates and dendrochronology data. These rates are presented in Table 2.2. The most striking aspect of the sedimentation rates is that the historical rates of unit 4 are more than an order of magnitude greater than the prehistoric rates of units 1–3. Such rapid historical sedimentation rates are consistent with the historical transformation of the landscape from forest to agriculture, which induced high erosion rates and greater sediment loads in Piedmont streams (Trimble 1974).

Another interesting difference in sedimentation rates is that observed between unit 1 (0.13 cm/yr) and unit 2 (0.01 cm/yr), where there is about an order of magnitude difference. This difference possibly is the normal product of levee aggradation and the hyperbolic decay in sedimentation rates as the levee built higher, which is not well represented by force-fitting the long-term average sedimentation rates (see Table 2.2). As a levee aggrades, fewer floods overtop it and fewer opportunities are available for levee sedimentation. Ritter et al. (1995:237–238) note that as a floodplain (or levee) surface is flooded less frequently, the rate of growth (sedimentation rate) is drastically retarded. They illustrate a hyperbolic function as the norm for floodplain sedimentation. Based on this nonlinear style of changing sedimentation rates, the differences observed between unit 1 and unit 2 could be viewed as intrinsic to the fluvial system and meaningless in terms of changes in climate and sediment loads. This would be consistent with the idea that the 7,270±60 date is too young. Alternatively, the relatively rapid

Table 2.2. Calculated Long-Term Sedimentation Rates from Radiocarbon Dates.

Sediment Interval (cm)	**Time Interval (years)**	**cm / years**	**Sedimentation Rate (cm/yr)***	**Pertains to:**
550–69	10,160–6,500	481 cm/3660 yrs	0.13 cm/yr	all of unit 1
550–170	10,160–7,270	380 cm/2890 yrs	0.13 cm/yr	lower unit 1
170–69	7,270–6,500	101 cm/770 yrs	0.13 cm/yr	upper unit 1
69–17	6,500–250	52 cm/6,250 yrs	0.01 cm/yr	unit 2
17–0	250–0	17 cm/250 yrs	0.07 cm/yr	unit 4 (on paleo-levee)
450–102	1960–250	348 cm/1710 yrs	0.20 cm/yr	unit 3
400–0	250–0	400 cm/250 yrs	1.60 cm/yr	unit 4
85–0 (tree 3)	70–0	85 cm/70 yrs	1.21 cm/yr	unit 4 (top)
125–0 (tree 5)	80–0	125 cm/80 yrs	1.56 cm/yr	unit 4 (top)

* These are long-term averages, representing the entire sediment interval

sedimentation rates in unit 1 may suggest more frequent flooding and sedimentation that were climatically driven during the early to middle Holocene between 10,000–6500 yr B.P. Many sites in the southeast register more rapid sedimentation rates during the early Archaic than during the middle Archaic (Leigh 1998; Schuldenrein 1996), but at these sites the relative importance of intrinsic versus extrinsic (climate) forcing mechanisms is not clearly understood. Indeed, at 31WA1137 the sedimentation rates in unit 3 are relatively high (0.2 cm/yr), but unit 3 is a low-lying fluvial surface that is quite subject to flooding.

At site 31WA1137 the issue of intrinsic versus extrinsic (climatic) forcing mechanisms on the sedimentation rates cannot be resolved, but it is clear that sedimentation rates on the crest of the paleo-levee slowed down considerably at about 6,000 to 7,000 yr B.P. This reduction probably made the crest of the paleo-levee a more favorable place to live and perhaps explains the appearance of cultural artifacts in unit 2.

Pedogenic History of the Paleo-Levee

Soil profile and geochemical data indicate that sedimentation of the paleo-levee was rapid enough to exceed (or keep pace with) weathering rates until about 6,000 to 7,000 years ago. About 7,000 years ago the depositional rates slowed so that pedogenesis was able to exceed sedimentation rates and began forming a distinct Bt horizon. The Bt horizon present in the upper part of unit 1 probably began to form c.7,000 years ago and continued forming throughout the late Holocene. Residual analysis of the percent of clay in the Bt indicates illuvial clay enrichment of about 2–7% (Appendix 3). The backslope of the paleo-levee contains the greatest amount of illuvial clay, which probably results because there is a thinner drape of unit 2 atop the Bt in that position, and because of a greater source of detrital fines on the backslope of the paleo-levee. The back levee part of unit 1 also is probably older then the southwestern part of unit 1, as indicated by the graded sequence and final lateral migration to the southwest.

As the sediments of unit 2 accumulated, c.6,500–2,000 years ago, unit 2 acted as a source of illuvial clays that percolated down through the profile and accumulated in the Bt in unit 1. Illuvial clay-iron bands that occur in unit 2 clearly indicate that clay illuviation extended into the time of unit 2 deposition (6000–2000 yr B.P.). In the Savannah River strata at the base of unit 2 illuvial clay-iron bands cover the cultural strata in some places, which clearly indicates illuvial clay translocation after about 6250 yr B.P. In fact, clay illuviation has probably continued throughout the late Holocene, so that some of the youngest clay-iron bands may be only hundreds of years old. At some time circa. 2000 yr B.P. sedimentation sufficiently declined on the crest of the paleo-levee so that an A horizon (now an Ab) could form, which contains the Woodland components. In the proximal facies of unit 2 no Bt horizon is present, and there is only a Bw and strands of clay-iron bands below the Woodland A horizon. This possibly indicates that the southwesterly lateral migration of the river channel and deposition of the proximal facies of unit 2 occurred toward the end of the time period of unit 2 sedimentation.

Summary

The sediments at 31WA1137 preserve a long record of Holocene sedimentation. Key aspects of this record include: (1) incision of the fluvial system to maximum depths, in fact to levels beneath the modern channel, occurred prior to 10,000 yr B.P.; (2) sedimentation rates on the crest of the paleo-levee since about 7,000 years ago have been considerably slower than those prior to that time, perhaps making the paleo-levee a favorable occupation site due to a low frequency of flooding; (3) clay-iron bands found in unit 2 are the product of clay illuviation (the downward translocation of clay within the soil profile) and not of flood sediments; (4) the Savannah River people probably were situated immediately adjacent to the active river channel, whereas later cultures saw the river migrate away from the crest of the pale-levee; and (5) the modern levee, though similar in form to the paleo-levee, accumulated under very rapid sedimentation rates that probably resulted from increased sediment loads in the Neuse River caused by historical land use transformations in the watershed.

SOILS

The overall project area is in the Appling-Louisburg-Wedowee soil association (Figure 2.14), which has gently sloping to steep, well-drained and somewhat excessively well drained soils that have a subsoil of friable coarse sandy loam to firm clay (Cawthorn 1970:6). These soils are derived from granite, gneiss, and schist. As is the case at Neuse Levee, the steep variants of the association mantle slopes adjacent to streams. The three constituents of the association each comprise about 20% of the total.

About half of the Appling-Louisburg-Wedowee association is cultivated, and the agricultural acreage is divided into farms of less than 200 acres. Tobacco, cotton, soybeans, and corn are the most frequent crops. The soil is easily tilled but susceptible to drought and erosion. Good private wells are common, yielding 10 to 15 gallons per minute, and the water supply is good except in times of extreme drought.

Neuse Levee is located on Congaree soil (Co, Cawthorn 1970:20) fine silty loam, not a recognized part of the association because it is on the floodplain. In a typical Congaree profile the surface layer is dark brown (7.5YR 4/4) to strong brown (7.5YR 5/8) fine sandy loam 4–12 inches thick. The subsoil is brownish yellow to dark grayish brown, fine sandy loam to silty clay loam 10–108 inches thick. The soil responds well to agriculture and most of the acreage in the county is in cultivation or pasture.

The nearby soil is Wake gravelly loamy sand (WkE, Cawthorn 1970:57), 10–25% slope. The Wake soils are generally a thin veneer over granite, gneiss, and schist bedrock. The top layer is brown (10YR 5/3) gravelly loamy sand. It is very acidic and generally covered in forest. They are excessively well drained and not good agricultural land. The type section for the soil is east of Wake Crossroads. Most of this soil type is in the northeastern part of the county.

Soil at the top of the valley wall is Weedowee (WmC2) sandy loam, 6–10% slope. Weedowee is highly acidic, deep soil that forms under forests and is currently important for agriculture.

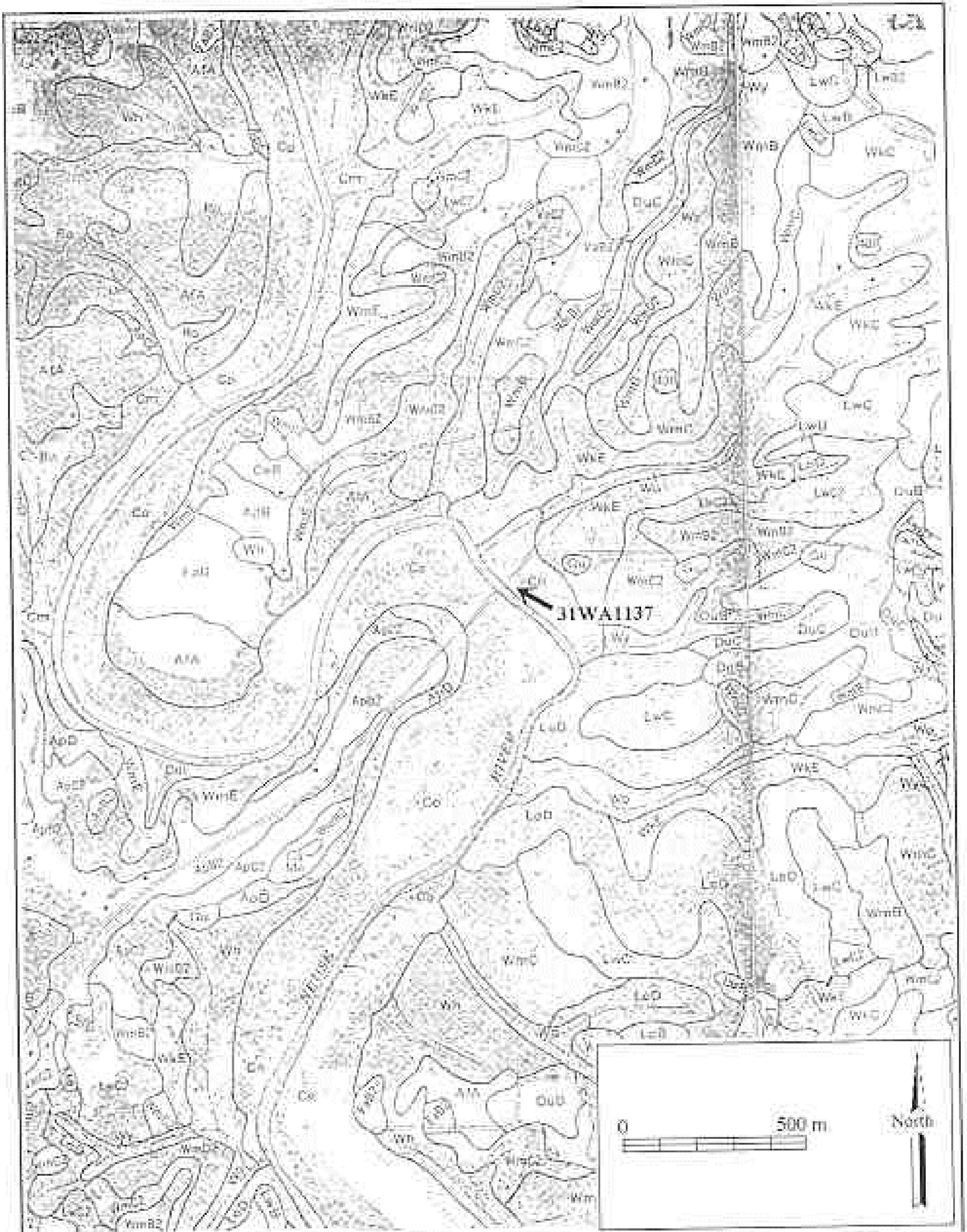

Figure 2.14. Soils of the Project Area.

CLIMATE AND PALEOCLIMATE

The modern climate of Wake County is characterized by warm summers and mild but occasionally cold winters. The average daily maximum temperature in Raleigh during July is 88.8°F, with an average minimum temperature of 68.7°F. During January the average daily maximum temperature is 50.3°F, with an average daily minimum temperature of 30.1°F. These averages conceal considerable variation, however, as two years in 10 will have at least four days with a July high temperature of at least 98°F and a January low of 13°F or less. The county averages about 220 frost-free days each year, with a standard deviation of 19 days. There are no distinct wet or dry seasons. The driest month on average is November, with 3.24 inches of precipitation, and the wettest month is July, with 4.44 inches of rain. Some snow falls in the county most winters, with a yearly average of about two inches (Epperson 1971).

Among the notable qualities of the southeastern Atlantic Slope are high evapotranspiration rates during summer (Currie and Paquin 1987: Figure 2.15). High evapotranspiration sponsors species diversity, so under prehistoric conditions North Carolina would have been one of the most diverse environments in North America. This might help explain the diversified and often unchanging subsistence economy in the region. If a group of people lives in a richly diversified environment and they learn to exploit a wide range of resources from that environment, then changes in the circumstances of that group will be obscured by their simply shifting the emphases of their subsistence within the existing range of resources rather than making qualitative changes in the food-gathering practices. They will not select a different range of resources under changed conditions, but will reapportion or reallocate the target resources to adjust to new conditions.

Dealing with cultural chronologies that span thousands of years and reach to times that are generally understood to have exhibited substantially different environmental conditions strains even the very broad-spectrum outlook on North Carolina's prehistory. The 11,000-year sequence of human occupation of the Atlantic Slope is divided into two broad climatic episodes. The earlier episode, before 8000 B.C., is the Ice Age, or Pleistocene. The period after 8000 B.C. is referred to as the Holocene. Studies of late Pleistocene climate around the north Atlantic basin have shown it to be somewhat different from that of the world at large (Broecker 1995; Kutzbach and Bryson 1974). Pleistocene conditions ended in most areas of the world around 13,000 years ago. This can be observed in North Africa (McBurney 1967) and in the southern United States (Delcourt and Delcourt 1983; Watts 1979, 1980). In the Midwest between 11,000 and 9500 B.C., warm, deciduous forests advanced as far north as the Great Lakes (Dreimanis 1977). However, due to the wasting of the Canadian Laurentide ice sheet, near-ice-age conditions reappeared in the Northeast and in northwestern Europe (Broecker and Denton 1990; Fitting 1974). The most pronounced of these cold episodes followed 9000 B.C., when runoff from the melting glacier suddenly shifted from the Mississippi River to the St. Lawrence River (Broecker and Denton 1988). The rush of cold fresh water from the St. Lawrence River disrupted the worldwide ocean circulation of warm water northward, returning the north Atlantic basin to ice-age–like conditions for about 700 years (Broecker 1995). It was a somewhat cooler period in most of the world, but was quite cold in northeastern North America. It should be thought of as resembling the Little Ice Ages of the last thousand years, rather than a reappearance of full glacial conditions. It was probably the first of the Little Ice Ages rather than the last of the great ice ages (Gunn 1992). During the Holocene, the Pleistocene glaciers retreated and finally disappeared.

These vast changes in global climate have been driven by several astronomical and geophysical influences. Over 23,000-year periods, wobbling of the earth's axis appears to have been the greatest influence (Table 2.3). The effects were the most dramatic in the northern hemisphere. During the ice ages, the north pole tilted away from the sun in the fall (Kukla 1975; Kukla and Gavin 1992). These dark falls allowed the glaciers to grow each year and eventually expand to immense proportions. For humans, the falls were probably visibly darker. The tilting reduced the supply of energy from the sun reaching the northern hemisphere by 7 percent in winter. During ice ages, seasonality was replaced by an equitable climate of permanent poleward winter and permanent equatorial summer, although the

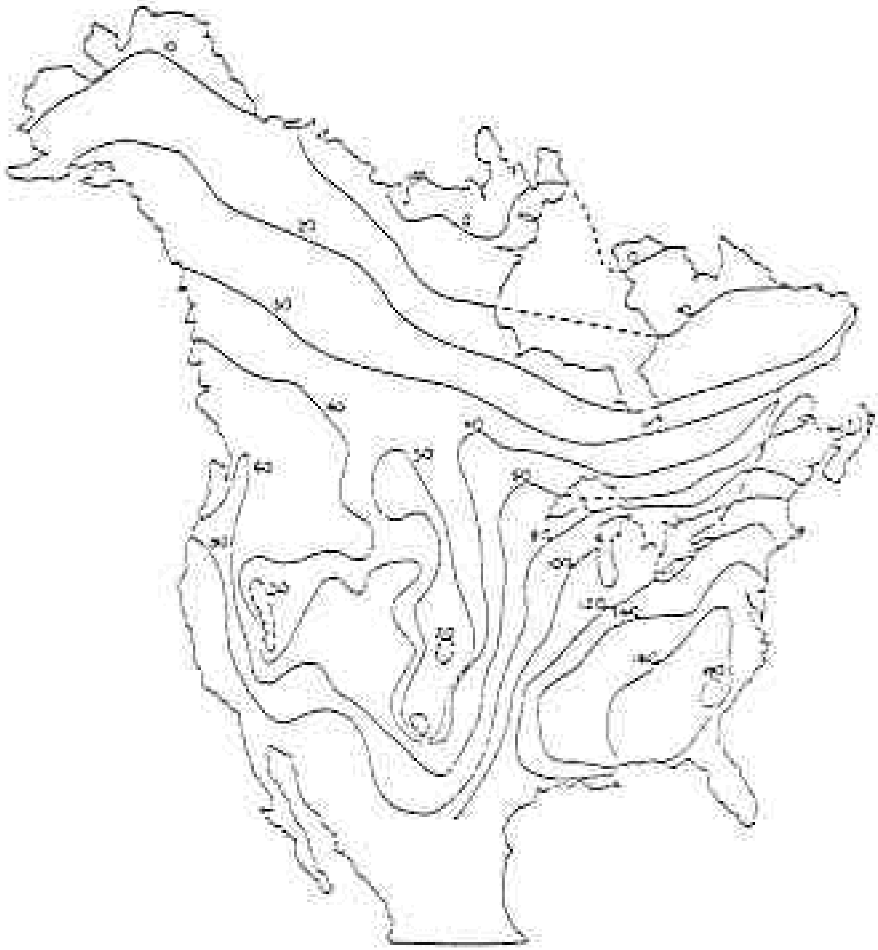

Figure 2.15. Evapotranspiration Rates in North America (as illustrated in Currie and Paquin 1987).

summers were cool like spring. During the Holocene interglacial, the tilt of the earth's axis shifted toward the sun in summer and away in winter (Bryson 1994; Davis and Sellers 1994). This would have resulted in bright, hot summers and dark, extremely cold, dry winters.

Of primary concern for this project is how these global conditions were reflected in local living conditions. Carbone's (1976) extensive environmental research on the Thunderbird site in Virginia revealed equitable seasons during the Pleistocene that produced a mosaic vegetation, a species-diverse, patchy arrangement of plant and animal communities. Overlapping the Middle Holocene (6200–3000 B.C. radiocarbon; corrected=7247–7100 B.C. to 3782 B.C. [Stuiver and Reimer 1993]), a mesic period characterized by hemlock and oak appeared in the mountains (Carbone 1976). At the same time, Watts (1979, 1980) suggests xeric conditions on the coastal plain. The coexistence of mesic conditions in the mountains and xeric conditions on the coastal plain and Piedmont is not inconsistent with the weather system processes of hot world conditions (Gunn and Foss 1992; Gunn and Wilson 1993; Millis et al. 1998). Moisture-laden summer winds cross hot, flat dry surfaces near the coast to inundate mountain uplifts.

Table 2.3. Global Climate Periods (Calendar) Driven by Rotational Wobble (Bryson 1994; Kutzbach and Guetter 1986).

Period	Seasonal Distribution of Energy	Dates
Pleistocene	Equitable	>11,000 B.C.
Latest Pleistocene	Somewhat Equitable	11,000–8000 B.C.
Early Holocene	Cold Winter, Hot Summer	8000–5500 B.C.
Middle Holocene	Cold Winter, Hot Summer	5500–2500 B.C.
Late Holocene	Somewhat Equitable	2500 B.C.–Present

Further information on moisture can be obtained by observing changes in coastal occupations and sea levels. Native American use of oysters on the shores of upper Chesapeake Bay did not appear until 4000 B.C. (Wesler 1985:214). Global sea level determinations (Tanner 1993) indicate that there was a high stand of sea level between 4800 and 3000 B.C. 2 m above that of the present. This may account for the sudden appearance of shell middens in the Chesapeake Bay at that time, because it would have moved the estuarine exploitation zone back from the present coast. It also suggests broad estuaries that could have supplied moisture to surrounding areas via on-shore winds.

There is also evidence of old low sea level stands. Blanton (1996) reports sites offshore in Chesapeake Bay discovered by watermen. Diagnostic artifacts date to the Late Archaic between 3500 and 1500 B.C. The sites are 5–8 m below current sea level. Local geologists argue that there has been about 2 m of land surface subsidence since the Late Archaic. Tanner's (1993) investigations of sea level revealed a –4 m low stand between 3000 and 2000 B.C., which overlaps the Late Archaic. This estimate corresponds with Blanton's dates and, when the subsidence is accounted for, it corresponds in depth as well. This finding suggests reduced estuaries and dry times in nearby uplands.

Tanner (1993) has found a method of documenting sea level changes over long periods of time by studying isostatically rebounding beaches on the eastern shores of Denmark. Since the beaches are lifted away from wave action, the recorded sea levels are not erased by subsequent changes. An 8,000-year sea level curve has resulted from these studies. Although the curve in Figure 2.16 is tentative relative to magnitude of changes, it provides an interesting background for discussions of areas heavily influenced by coastal shallows, of which North Carolina is the premier example on the Atlantic seaboard because of a broad, gently sloping Coastal Plain and continental shelf. Among other interesting characteristics, there is a distinct change in the mean and amplitude of variations at 3000 B.C., a date that figures prominently in regional cultural and environmental changes. Mathis (1998), for example, has found that shell-tempered ceramics are confined to the northern coastline, where shallows support greater numbers of shellfish.

Changing sea level influences seasonality of precipitation. The seasonality of precipitation is one of the key factors in human adaptation to a region and is also reflected in land surface stability (Gunn, Folan et al. 1995; Gunn and Foss 1992). Land surface stability is of first importance in searching for archaeological sites and reconstructing landscapes. This is particularly so in areas where changes in the water table induced by base level can have widespread effects far beyond the coastline. The lower Savannah River valley has recently been suggested as a location where minor sea level changes influenced conditions far inland (Brooks et al. 1986; Brooks et al. 1989; Gunn, Lilly et al. 1995).

It should not be assumed that climate changes were confined to the prehistoric era. For example, changes in climate since the eighteenth century have had significant impact on local productivity and world commerce. They are the subject of much investigation (Gunn 1994a; Williams and Wigley 1983). North's (1966) study of grain prices in Europe during the 1700s shows them to be low early in the eighteenth century and high late. This trend is attributable to a favorable grain-growing climate in Europe early in the century and poor later (Bryson and Murray 1977). More local information can be obtained from Stahle et al.'s (1988) studies of tree rings from the last 1000 years on the Atlantic Slope.

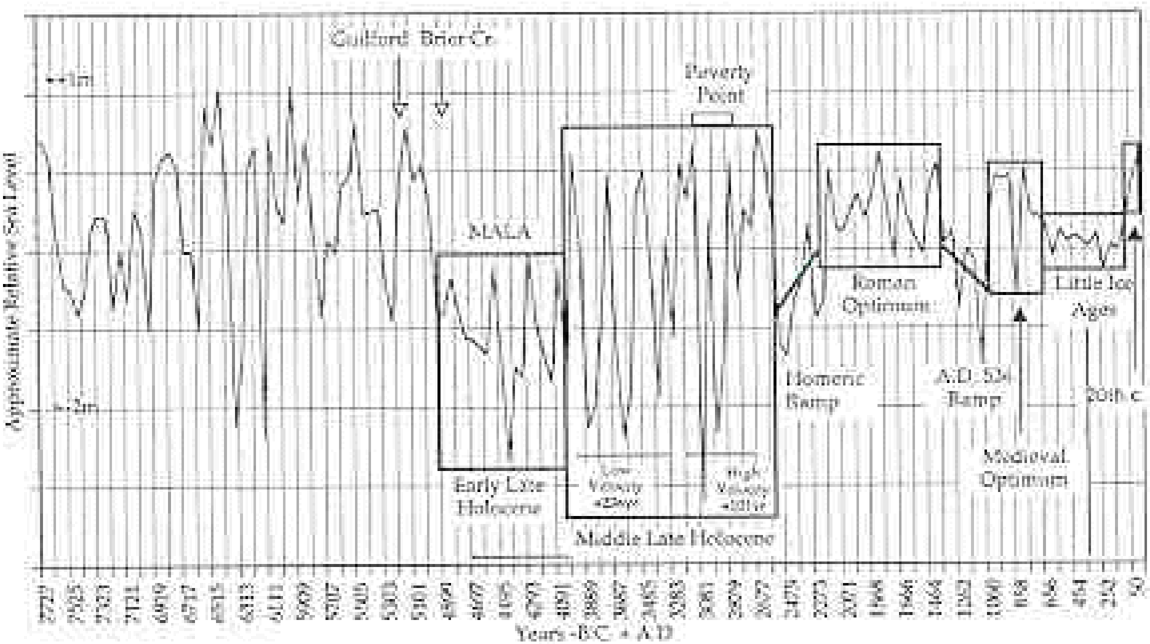

Figure 2.16: Tanner Sea Level Curve for the Middle and Late Holocene (Tanner 1993).

In the last decade, Stahle and his co-workers (Stahle et al. 1988) have established tree ring chronologies for Atlantic Coast states. This allows investigators to set the entire historic period and part of the prehistoric period in year-by-year climatic context. A Virginia tree ring chronology has been created and used along with the Black River chronology to study the conditions early settlement on the North Carolina and Virginia coasts (Stahle et al. 1998). The chronology from the Black River in North Carolina shows that the decades following colonization at Jamestown provided relatively reliable late spring moisture (Figure 2.17). This period extended into the time when antebellum planters lived in the project area. The early decades of the nineteenth century, however, were characterized by increasingly unreliable late spring moisture.

Anderson et al. (1995) have applied a similar methodology to the climatic backdrop of the Mississippian period along the Savannah River in South Carolina and Georgia. They studied the influence of variable moisture on the late prehistoric and early historic populations of the Savannah River valley. Unless accounted for by social changes, population and complexity of social organization increased during long episodes of adequate moisture. During intervals of variable and inadequate moisture, and perhaps during periods of excessive moisture, population and complexity tended to decrease. During the historic period, Spanish colonial efforts on Saint Helena Island failed during a lengthy episode of drought.

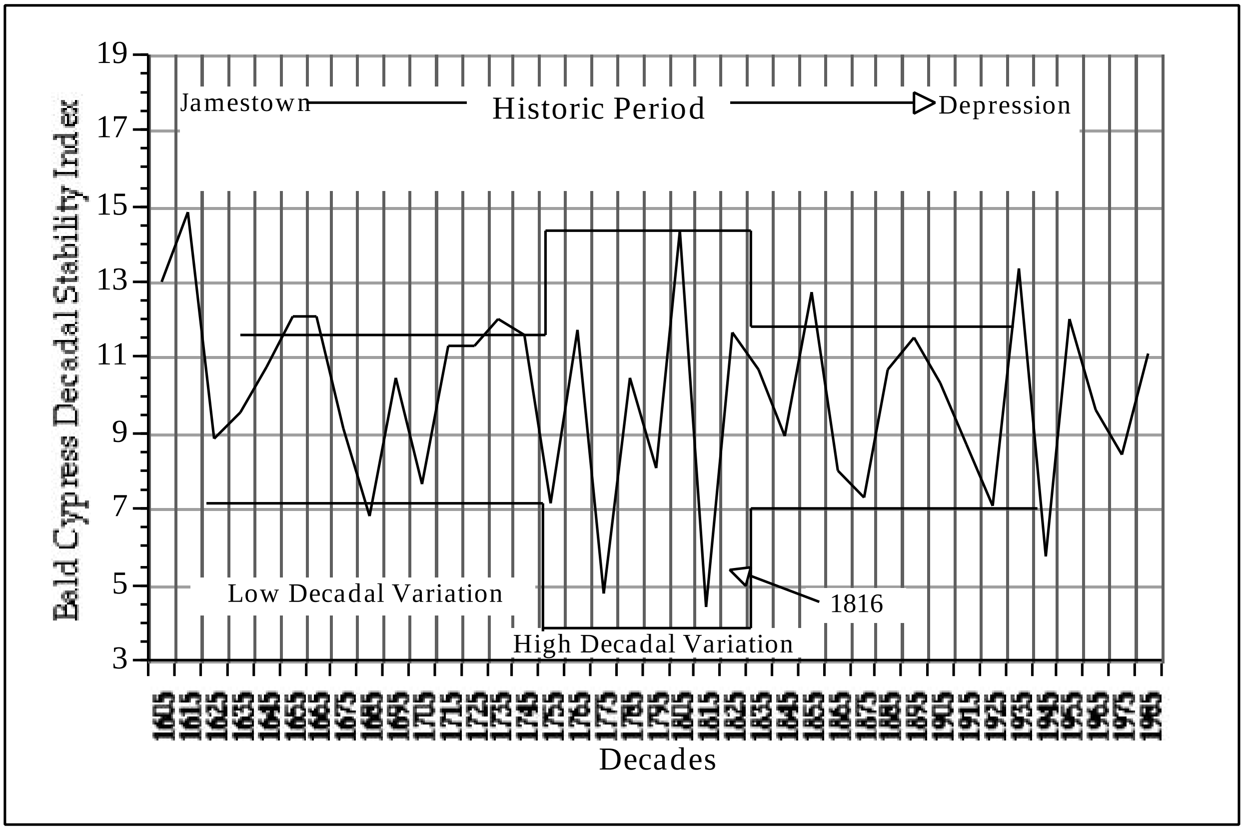

Figure 2.17. Late Spring Moisture during the Historic Period, by Decades (Stahle et al.1998).

FLORA

Prior to the initial European settlement, the project area supported diverse hardwood forests. The uplands and higher stream terraces supported such species as red, white, black, chestnut, southern red, scarlet, and post oaks, pignut and mockernut hickories, tulip poplar, American chestnut, sweet gum, and black gum. Shortleaf, Virginia, and white pine were present in some areas, along with red cedar. Dogwood, holly, sourwood, and other species were common in the understory. The floodplains along the river and its major tributaries supported stands of oaks, shagbark and bitternut hickories, American beech, tulip poplar, black walnut, American and slippery elms, white and green ashes, red, silver, and southern sugar maples, sweet gum, black gum, sycamore, and other species. Black willow, red maple, sycamore, green ash, sweetgum river birch, and water oak were present on the more poorly drained soils. It is thought that human activities played a significant role in shaping this habitat, perhaps changing the species composition to one more favorable to their subsistence practices (Hammett 1992a, b; Tippitt and Moss 1996). This is particularly so in the case of the floodplain, which could have been subjected to hundreds if not thousands of years of low-level species management that could have approached, if not achieved, horticulture.

FAUNA

Numerous species of migratory and native fauna inhabited the project vicinity prior to and during its early settlement and were available for exploitation by both prehistoric and early historic populations. Major mammalian game species present in the area included white-tailed deer, elk, black bear, squirrels, and rabbits. Avian species of likely importance to the early inhabitants of the area included turkey and quail, and the river and streams would have provided a variety of fish and other freshwater animal resources. Of special interest to this study are the habits of migratory or anadromous fish, which before the damming of North Carolina rivers arrived in great numbers to spawn in the spring.

Riverine Subsistence Resources

Many species of fish inhabited the Neuse River in prehistoric and early historic times. Some freshwater species dwelt in the river near the location of their birth the year around. Others, the anadromous species, hatched in upstream spawning grounds and swam to sea, returning to fresh water only to breed (Millis 1998). Peak migrations of anadromous fish in the Neuse River occur from March through May, when water temperatures are approximately 11–26°C (Hawkins 1980:94–95). Most anadromous fish return to their home streams to spawn, possibly guided by light intensity and/or olfactory ability to taste/smell familiar chemical signatures of individual rivers. Although there is some variation among species, in general anadromous fish have very distinct migration periods and routes.

A diverse collection of fish remains has been identified from sites throughout North Carolina. According to Scarry and Scarry (1997), 63 taxa of fish have been identified from North Carolina archaeological sites. Most of the fish remains represent freshwater species, although marine fish are also significantly represented. Only four species of anadromous fish have been recovered from archaeological sites in North Carolina: white shad (*Alosa sapidissima*), Atlantic sturgeon (*Acipenser oxyrhynchus*), gizzard shad (*Dorosoma* sp.), and stripped bass (*Morone saxatilis*). One species of catadromous fish (migrates downstream to breed in salt water), American eel (*Anguilla rostrata*), has also been recovered from Native American sites in North Carolina (Scarry and Scarry 1997).

Fish remains recovered from archaeological sites in North Carolina are primarily associated with the Late Woodland period. A few remains have been recovered from Middle Woodland and, to a lesser extent, Early Woodland contexts. A few sites dating to the Mississippian, Protohistoric, Contact, and Historic periods have also yielded fish remains (Scarry and Scarry 1997). Although fish remains have been recovered from numerous sites in the Coastal Plain, Piedmont, and Mountainous regions, anadromous fish remains are relatively rare at these sites. In the Piedmont region, white shad (*Alosa sapidissima*) has been recovered from a Contact-period context at Lower Saratown (31RK1) on the Dan River (Holm 1993). Shad (*Alosa* sp.) and gizzard shad (*Dorosoma* sp.) were identified at the Donnaha site (31YD9) on the Yadkin River from Late Woodland contexts (Mikell 1987a). At Coastal Plain sites Atlantic sturgeon (*Acipenser oxyrhynchus*) and shad/herring (Clupeidae) were identified in Late Woodland contexts at the Flynt site (31ON305) (Mikell 1987b; Waselkov 1987). Sturgeon (*Acipenser* sp.) and striped bass (*Morone saxatilis*) have also been recovered from Late Woodland contexts at Jordan's Landing (31BR7) (Byrd 1997).

Although no boney fish remains were recovered at Red Hawk Run (31WA1376) at Wakefield Plantation 7.2 km upstream from Neuse Levee, exceptionally elevated levels of phosphorus were detected in the site along with a deposit of burned rock detritus (Gunn et al. 1998). This is presumed to have been a fish processing area. Elevated phosphorus levels were also found in the Late Woodland levels at Neuse Levee and could represent fish processing (see geomorphology section above).

Upland Subsistence Resources

Like most parts of the world, the pre-European and pre-African plant community on the Atlantic Slope was not that of a landscape unmodified by humans. Humans have been aggressively interacting with plant species by fire for at least a million years. When John Smith (Kupperman 1988) explored the Potomac River drainage in 1608, he reported that the vegetation of the Coastal Plain and Piedmont were open woodlands characteristically maintained by local peoples through annual burning of underbrush. A captured warrior reported to Smith that areas to the west were referred to as the "unburned" lands. This unburned land was mountainous and inhabited by people who lived by hunting and collecting wild plants. The area referred to was undoubtedly the Appalachian Mountains, but the account is unclear as to whether it included the Blue Ridge front. Later evidence suggests that the burned lands might have extended west as far as the Shenandoah Valley. Even in the 1800s, Kercheval (1925) observed the presence of old fields, abandoned Native American villages, and farms in the lower Shenandoah Valley. Like the Chesapeake Bay area, North Carolina, and the greater part of arable lands in the East during the last few hundred or thousand years, was probably an anthropogenically modified landscape. Hammett (1992a:1; 1992b), reporting on the observations of explorers before 1750, found that "the well-organized use of burning, clearing, and planting . . . created and maintained a mosaic of managed patches that yielded high subsistence returns and ensured the short term stability of their anthropogenic ecosystem." Most likely before the decline of Native American population at Contact, the landscape contained large nut-bearing trees in the midst of relatively open grasslands, a landscape mistaken by some to be "natural" (Tippitt and Moss 1996; Woodall 1996).

The intervention of humans to prevent total forestation benefited them in numerous ways (see above). White-tailed deer and turkey are typically forest-edge dwellers (Larson 1980). Their populations, therefore, would have been much larger than in closed forests. Though less evident, it is clear that larger game were also more populous. Wayland (1976:9) reports that Bull Skin Creek, in present Jefferson County, West Virginia, in the lower Shenandoah Valley, was so named because early explorers or prospectors found a buffalo bull skin staked out on the bank to dry. Although the absence of bison bones in archaeological sites east of the Appalachians (Ward 1990) remains a puzzle, elk bone is clearly present, especially in the Late Woodland and is therefore for the present more accessible for investigation. The proximity of elk and perhaps bison, as will be discussed below, raised interesting questions about upland resources in the upland surrounding the Neuse Fall Line region during periods when the uplands were maintained either by climate or human intervention as open vegetation. In his summary of Late Woodland cultures, Potter (1993:147) notes that early Europeans observed agricultural villages located on floodplains. Beyond 2 km (1.24 miles) from the floodplain were small hunting and gathering sites used only briefly by small groups of people.

In addition to the historical observations, it is known that bones of large animals such as elk and bear have been identified in pit features in Late Woodland sites in the North Carolina Piedmont (Scarry and Scarry 1997) and in the Potomac Creek Complex sites of Accokeek Creek (Stephenson et al. 1963:58). Such large animals would have required considerable range to feed. If the interior flats were an appropriate mix of forest and open forage, they could have provided the large-game part of the Late Woodland diet. As noted above, Smith (Kupperman 1988) recorded that the Native Americans maintained an open habitat in the Coastal Plain by burning, and thus might have systematically contributed to the well-being of large animals. Beverley (1947:124) observed of Virginia that "In some Places lie great Plats of low and very rich Ground, well Timber'd; in others, large Spots of Meadows and Savanna's, wherein are Hundreds of Acres without any Tree at all; but Reeds and Grass of incredible Height. . . ." This suggests a prairie forest mix frequently was found at contact in the eastern woodlands (Jordan 1973).

Geographically there might have been discrete ranges of elk and bison. In his observations of elk while surveying the North Carolina–Virginia border, Byrd (1967:236) noted that elk tend to live north of 37° latitude, while bison were to the south. This is the latitude of Newport News, Virginia, about 100 km (60 miles) north of the Neuse Levee site.

Understanding what the early historic authors meant when discussing elk requires an understanding of the terms used now and then, especially in the cases of Smith, Lawson and Byrd who appear to have been conversant with both North American and European species. The term "elk" is applied in Eurasia to the largest species of the deer family (*Alces alces*), known in North America as *moose (Alces americana*). American moose is larger than the European species (7.5 ft. and up to 1800 lbs). Moose are browsers in the northern coniferous forests. In North America "elk" is limited to the "wapiti" (*Cervis canadensis*). The wapiti, which is about 5 ft tall with 5-ft antlers and weighs 1000 lbs, is related to the European red deer (*Cervis elaphus*). Red deer are about a foot smaller than the wapiti. The wapiti once inhabited all of temperate North America, but in the East was hunted to extinction for furs, meat, and canine teeth, which were regarded as a charm. Though reduced in numbers, wapiti subspecies remain in the west.

Early historians regularly recorded observations and comments on elk and bison (Table 2.4). These animals appear to have been numerous in 1600 and all gone except for elk in the Appalachian Mountains by the American Revolution.

It is unlikely that there are modern studies of elk behavior in the East, although there may be family records with pertinent observations in the Appalachians (W. Roberts, personal communication 1998). Some insight that is possibly applicable to the behavior of eastern elk can be gained by studying the literature on western elk. Various investigations have been made of elk ecology and behavior. A study in Carter Lake National Park in western Oregon (Jenkins et al. 1985) used radio collars to track the movements of elk (*Cervis elaphus roosevelti*) over about two years. The animals migrated through three discrete forages between winter, spring, and summer. The summer range was in the Cascade Crest, the spring range to the east of the Cascade Mountains, and the winter range to the west of the mountains. The distance from the winter to spring range is about 35 km and from spring to summer 16 km.

Table 2.4. Large Game, Especially Elk, Reported by Early Observers.

Observer	Date	Observations
Smith (Kupperman 1988)	1607	? in Virginia. Moose, elk? ("Deare red"), and "Deare fallow" in New England
Byrd (1967)	1728	Elk north of 37° lat., bison south, elk encountered 30 miles from mountains (p. 236)
Lawson (Lefler 1967)	1701	Elk same range as bison (p. 129), bison seldom appear among English, mostly westerly in "Messiasippi," "Buffelo or wild Beef," and elk listed (p. 120), Toteros were tall men having great plenty of "Buffelos, Elks, and Bears," (p. 54)
Beverley (1947)	1704	French aspire to tame Buffaloes by capturing calves (p. 282), Indians fire hunt bison, elk, deer
Bartram (1980)	1776	Bison gone, elk confined to Appalachians (p. 3)

During the summer the elk browsed the Cascade Crest environment, arriving during April or May. Migration times and routes were individualistic, spanning about a month. Mountain hemlock/red fir forests were the preferred cover, and foraging was in dense patches of smooth woodrush. The animals were generally dispersed during the summer. Calving was in the remote headwaters of streams.

Sometime in September or October they were driven by snow from higher elevations into the spring range, and then into the winter range by November. This migration required passage through the Cascade Mountains to the winter range. Fall migration times were highly variable, depending on the first snowfall, and the animals would return to the summer range if snow melt allowed it. On one occasion it is thought that they returned to the summer range because of hunting pressure. Much of the winter was spent in forests classed as "elk thermal cover" with excursions to clearcuts of shrub-sapling less than 20 years old to forage.

For the eastern seaboard Coastal Plain, a pattern of migratory behavior such as that described for the western elk might include summers in the Appalachian Mountains and winters in the Coastal Plains. Perhaps the elk bones at Accokeek Creek and Potomac Creek suggest that at least the Coastal Plain of Virginia and the Western Shore of Maryland were included in such ranges. The short migration distances might confine elk to the Piedmont near the mountains. This would conform with Lawson's discussion of "Toteros" subsisting on bison and elk in the western Piedmont of North Carolina. Also, Byrd was within 30 miles of the mountains when he encountered elk. Since Byrd was surveying the Virginia–North

Carolina line, his and Larson's locations of elk correspond, both pointing to the high Piedmont around Wilkes and Surry counties. If similar patterns held in Virginia, it could imply that elk were brought from a distance to the Potomac Creek Complex sites. However, most hunters take care not to transport bone long distances. Bones in village middens would therefore argue for hunting near by. The relatively abandoned but maintained state of the interior uplands during the Late Woodland could well have encouraged the wintering of large game in the Coastal Plains areas. As such, elk and other species would have been available to small hunting parties originating in floodplain villages, as outlined by Potter.